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Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE GROSS EARNINGS OF 145 RAILWAYS for the month of February, according to statistics collected by the *Financial Chronicle*, are $33,484,366, as compared with $32,154,992 for the corresponding month of 1890, an increase of 4.13%. This is a very favorable showing, considering the various drawbacks to large earnings and the fact that the earnings for February, 1890, were exceptionally large. In regard to the various roads the results have been very irregular, there being some very heavy gains and also some large losses. Of the total 145 roads, 52 show decreases.

The SAULT STE. MARIE LOCK, on the improvement of the St. Mary's River, Michigan, will be 800 ft. long between hollow quoins, and 100 ft. wide, with 22.4 ft. over the miter sills at a mean stage of water. The total length of each lock wall is 1,025 ft., and the volume of masonry in the lock walls 80,000 cu. yds. There will be 3 sets of lock gates, and 2 sets of guard gates. Each leaf of the lower lock gates and of the intermediate gates will weigh about 150 tons. All the gates will be of metal. The hydraulic machinery will be very similar to that in use at the present lock. The work is in charge of Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.

A RAPID TRANSIT COMMISSION IN BOSTON is proposed by the Massachusetts Legislature, which is now considering a bill establishing such a body. According to the bill, the Governor is to appoint within 30 days from the passage of the act, 3 persons, none of them residents of the city, who, together with the Mayor, City Engineer and the present city transit commission, shall consider all questions relating to rapid transit, both passenger and freight, arising in that place. They are to investigate not only routes, stations and details of construction, but also the financial questions concerning franchises, condemnation proceedings and damages.

THE ZALINSKI PNEUMATIC GUN has been tested at Shoeburyness, England, with marked success, according to a cable dispatch. At 4,000 yds. range 6 projectiles were thrown into a rectangle 2½ × 1½ yds. in size.

THE GULF DRY DOCK COMMISSION has recommended Algiers, that part of New Orleans on the right bank of the Mississippi, as the most suitable site. The primary requisites for this dock are a clear channel to the sea with a depth of at least 25 ft., stability of foundation to support a load of 15,000 tons, and a protection by a distance of 12 miles or by an intervening elevation of the ground from gun fire from the sea. After a personal inspection of all such places on the Gulf, the commission reports unanimously in favor of New Orleans.

PROPOSALS FOR A NEW CRUISER of 7,300 tons displacement, "commerce destroyer" type, have been invited by the Navy Department. The vessel is known as No. 13 and must develop on an open sea trial trip a speed of not less than 21 knots an hour for 4 consecutive hours, under a penalty of $25,000 for each quarter knot deficiency.

THE PATENT CENTENNIAL EXERCISES, to celebrate the beginning of the second century of the American patent system at Washington on April 8, 9, and 10, bid fair to be very successful. All of the railways leading into the capital have reduced their rates for the occasion, and a great crowd is expected. President HARRISON will open the celebration, and the literary exercises will be presided over by some of the most eminent inventors and engineers in the country, by whom 20 addresses upon the different phases of invention will be delivered. A national association of inventors and manufacturers of patented articles will be formed. There will be a grand reception at the Patent Office by the Secretary of the Interior and Commissioner MITCHELL, at which it is expected that CYRUS W. FIELD, THOS. A. EDISON, GEO. WESTINGHOUSE, JR., GEO. M. PULLMAN and others will assist. This is the first time in the history of the Republic that inventors have had any celebration, despite the great part which they have played in national development, and the exercises will beyond doubt be interesting and significant.

THE INTER-CONTINENTAL RAILWAY will, it is reported, start from either Minatitlan or Tehuantepec, in Mexico, and run to Jujuy, in the Argentine Republic, where it is to connect with the Argentine railway system. Mr. W. F. SHUNK, the Chief Engineer, recently told a representative of the Philadelphia *Press* that the surveys will take not less than 12 or 15 months. The greatest difficulties are expected in the neighborhood of Guayaquil, in Ecuador. Two parties will start from that city, one working south through the Peruvian Andes to La Paz and through Bolivia to Jujuy, the other going northward through Ecuador and Colombia to Antioquia and the Isthmus of Panama. Twelve engineers will probably be employed on the work, the additional help being engaged in the countries traversed. The party will probably sail early in April.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a double-header passenger train on the Richmond & Danville R. R., near Danville, Va., on March 11. The train was south-bound and had just left Danville. It consisted of 1 mail and express car, 1 baggage car, 2 day cars and 4 sleeping-cars, and had an engine in front of the regular engine to assist the train up the grade as far as the Danville & Western junction. At a curve about 4 miles from the city the tender of the front engine left the track and was followed by the second engine and tender. The mail car was telescoped and the baggage car thrown into the ditch. The passenger cars were not much damaged and the sleepers did not leave the track. One man was killed. In a derailment on the Chesapeake & Nashville Ry., near Bethphage, Tenn., on March 12, the mail car and a passenger car went down a 15-ft. bank. The mail car caught fire from its stove and 3 cars were burned.

THE TERMINAL SHOPS AT TACOMA of the Northern Pacific R. R, are receiving numerous additions. There have been recently erected large coach and repair shops, a machine shop 120 × 244 ft., a 22-stall roundhouse, large coal sheds and a number of smaller buildings.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: A bridge on the Central Vermont R. R., near Middlebury, Vt., was burned March 11. The covered bridge across the river at Hanover, N. H., has also been burned. Part of the new bridge of the Albany, Florida & Northern R. R. across the Flint River, Ga., was washed away March 12. Several railway bridges in Mississippi have been washed away by the floods. A trestle on the Carolina Central R. R., near Ledbetter's, was wrecked last week by a derailed tender truck of a freight train, and 13 cars were thrown into the water.

THE CONSOLIDATED CAR HEATING CO. exhibited on March 11 and 12 its steam heating apparatus, with automatic temperature regulators, in use on the Belt line trains of the Delaware & Hudson Canal Co., running between Troy and Albany, N. Y. The exhibition was attended by prominent railway officers from all parts of New England and the Middle States. The Delaware & Hudson Canal Co. is the first to adopt these automatic temperature regulators for all trains over one line. The system of heating used is the Consolidated Co.'s commingler system, illustrated and described in our issue of Sept. 6, 1890. The automatic temperature regulators keep the cars at 70°, no matter how cold the outside air, and are guaranteed not to permit a variation of more than 2° either way. That this is a vast improvement over ordinary practice, in which the temperature of the cars is [not] regulated by the brakemen, every traveler will testify.

THE STEAM HAMMER AT SOUTH BETHLEHEM, in the works of the Bethlehem Iron Co., was designed by Mr. JOHN FRITZ, Chief Engineer of the company, for forging armor plates for the navy. Over the anvil, which weighs 1,400 tons, is a 475-ton frame 90 ft. high. The tup has a stroke of 18 ft. and weighs 125 tons. The total weight is 2,000 tons. In describing this hammer *Harper's Weekly* says: "One can perhaps more clearly realize what the direct plunge of a weight of 125 tons means if he considers that it is equal to the weight of 2 regiments of soldiers, or 1,700 men, but having even more impetus, because concentrated in a solid mass."

FIVE NEW YORK-BROOKLYN BRIDGE BILLS are now before the Legislature. One is the old Blackwell's Island and Long Island City project, another is advocated by a ferry company, a third by the Brooklyn Elevated R. R., and the others are proposed by Judge G. W. Greene, of New York & New Jersey Bridge Co. fame. There can be no doubt whatever that more bridges are needed, not to relieve the present bridge, for they will not, but to furnish more direct communication for the East New York and Williamsburg districts.

THE FIRST STEEL STEAMER BUILT ON LAKE MICHIGAN was launched March 14 at the yards of the Chicago Ship Building Co. The vessel is 308 ft. long over all, 40 ft. wide, and is built for the ore carrying trade.

THE LATEST RAPID TRANSIT PLANS FOR NEW YORK are those presented to the Rapid Transit Commission on March 13 by the City Ry. Co., which proposes to construct a subway so near the surface that a roof or covering resting upon heavy girders makes it merely a covered way and not a true underground line. Four tracks, two for local and two for express traffic, and electric propulsion are proposed.

INDICATORS FOR STEAM ENGINES are now made of aluminum by Dreyer, Rosenkranz & Droop, of Hanover, Germany, who find that this metal offers many advantages for this purpose, owing to its light weight.

THE TRIAL OF THE GUNBOAT BENNINGTON is interesting in that it shows the uncertainty of naval architecture. The vessel was built from the same plans as the Concord, in the same shipyard and with the same care, yet the latter boat slightly exceeded the required horse power while the Bennington has fallen 87.31 HP. under the 3,400 HP. called for in the contract. This is only 2½% decrease, however, and Chief Engineer R. B. HINE, U. S. N., who had charge of the tests, is reported as saying that it was a very successful trial and that the Board considers the vessel satisfactory in every respect.

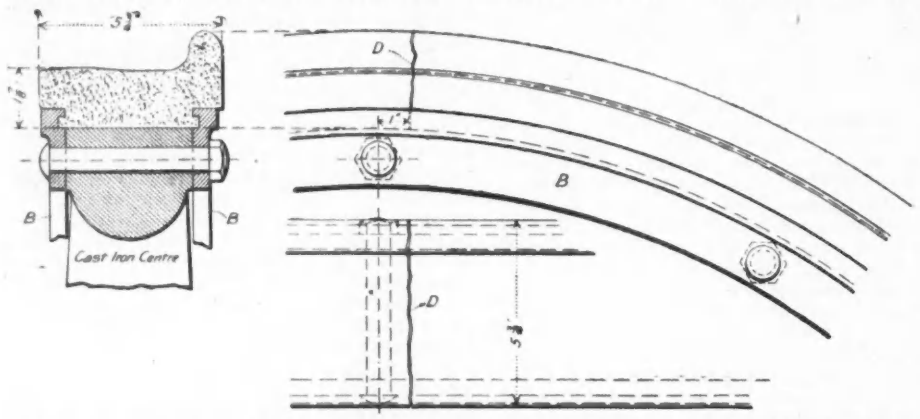
THE ERICSSON TORPEDO-BOAT DESTROYER has been docked preparatory to being fitted with an improved submarine gun, for which Congress appropriated $30,000 more than a year ago. The projectile will, it is said, be about 25 ft. long and carry from 300 to 400 lbs. of nitro-glycerine. The gun will be tried at the Newport torpedo station within the next few months.

A Broken Tire Accident Averted.

In our issue of July 19, 1890, we illustrated and described the practice of the Lake Shore & Michigan Southern Ry. in regard to retaining rings for locomotive tires. In another issue (Dec. 6, 1890) and in various others we gave full details as to all the various modes of attaching tires to wheel centers, the Mansell retaining rings, so called, being now practically established throughout the world as the best and only absolutely certain preventive—not of tire breakage, for nothing can well do that, but of aceident therefrom.

By the kindness of Mr. GEO. W. STEVENS, Superintendent of Motive Power, we are enabled to show herewith a very prompt and decisive proof of the wisdom of the L. S. & M. S. Ry. in adopting this important safeguard. The tire fracture shown in the accompanying illustration happened a few days since (March 3, 1891) to engine No. 82, hauling the fast night express train No. 12. This train is scheduled to run a distance of 130 miles without stop at the rate of about 40 miles per hour. During this run, however, 25 minutes of time was made up, so that was really considerably higher.

When the engine reached the engine house after making this run the tire was found broken nearly square across, as shown. As will be seen from the accompanying section the tire was still tolerably thick, 1⅛ins.,and only moderately worn in the tread,and the fracture was wholly without visible cause or excuse. Such fractures usually are. At what point in the run it occurred cannot now be known, but it is almost certain that except for the retaining rings, the tire would have left the wheel, and it is quite possible that the result would have been as serious as at the St. George disaster on the Grand Trunk Ry. about two years before, when a score or so of lives were lost as an effect of a similar breakage; since which date the Grand Trunk Ry. has been using Mansell rings on the wheels of its passenger engines.



BROKEN TIRE HELD BY MANSELL RETAINING RINGS; LAKE SHORE & M. S. RY., MARCH 3, 1891.

This being so, it is interesting to note that, as we showed more fully in our former article above referred to, the total cost of this appliance is only $73.17 per engine, of which not less than $53.68 is for the rings themselves, which are practically indestructible, and only $19.49 for the work of applying these rings to an engine.

There are now somewhat over 32,000 locomotives in the United States, of which perhaps one-fourth are passenger engines, and about half of these passenger engines, or some 4,000 in all, are run at speeds which are likely to make a tire breakage, if it occurs, a pretty serious matter. At $75 per engine for equipping these latter with Mansell rings, the total cost would be $300,000, which is less than the cost of a single first-class accident.

As an assurance against such an accident only, therefore, such an expenditure could be defended on economical grounds alone, but there is a still other argument in favor of using such rings, however—viz., that the tires can then be safely run for at least another turning, which we need hardly say is in itself an economy which is cheaply purchased at $20 to $75 per engine.

In a note transmitting the blue print from which our engraving is made, Mr. STEVENS states the circumstances as follows:

Feeling assured that you take pleasure in knowing of and making known meritorious devices I take pleasure in submitting herewith a blue print illustrating a fractured tire, fitted with Mansell retaining rings, which lately broke on one of our express train engines. The discovery of the fractured tire was made at engine house after making a run of 130 miles, during which time about 25 minutes was made up on schedule. The engine was No. 82, 17×24 cylinders and 56 in. drivers. The retaining rings held the tire perfectly to its place, were in no manner disturbed, and, to all appearances, the engine could continue to perform service with safety. In the absence of the retaining rings what might have happened is only conjecture; but, from past history, it can safely be concluded that the fractured tire would, at least, have necessitated a tedious delay to train. The blue print shows the fractured tire as it actually appeared upon the wheel, and the retaining rings are silent witnesses giving conclusive evidence as to their utility.

The Proposed Pennsylvania Ship Canal.

From the official report of the Commission to the General Assembly of Pennsylvania of 1891, we make the following abstract respecting the feasibility of a ship canal connecting the waters of Lake Erie and the Ohio River. This commission was appointed on Oct. 9, 1889, and is made up of the following gentlemen: JOHN A. WOOD, W. S. SHALLENBERGER, EBEN BREWER, JOHN M. GOODWIN and Col. THOMAS P. ROBERTS. Mr. WOOD was made president of the commission and Messrs. ROBERTS and GOODWIN were jointly charged with the direction of the engineering operations, plans, estimates of cost, etc.

It should be stated at the beginning that all elevations given in the report, except when other data are mentioned, refer to mean high tide at New York City. The mean level of Lake Erie is 572.89 ft. above mean high tide, and the surface of water in the Davis Island Pool, near Pittsburg, is 699.29 ft. above tide, or 126.40 ft. above the mean level of Lake Erie. These are the levels at the entrances of the proposed canal, and the summit level as fixed by the commission is 1,016 ft.

Commencing at Lake Erie the general route of the canal can be laid down as follows: Starting at Conneaut Harbor, in the State of Ohio, the line passes south by east, and crosses the boundary into Pennsylvania about at the 22d mile of the canal line. The lockage commences almost at the lake and in 12.36 miles, by 25 locks, the canal reaches the 20 mile summit level mentioned, rising 433.11 ft. in this distance. The advantages of this long summit level will be referred to later.

Following down the valley of the Shenango Creek the canal, about Jamestown, Pa., strikes a level of 10.35 miles between Jamestown and Greenvile. From this point the line follows generally the valley of the Shenango River, cutting across the heel of the Big Bend in Mercer Co., and reaches the Ohio River at Rochester, descending, in this distance, by 26 locks, a vertical height of 310.71 ft. The distance from lock No. 48, near New Brighton, to Davis Island Dam is 28.4 miles. The total length of the canal by this route would be 128¾ miles from Lake Erie to Pittsburg.

The section of canal proposed by the commission would have a bottom width of 100 ft. and a normal water depth of 15 ft.; with side slopes determined by the character of the soil passed through. The general surface width would be from 152 ft. to 163 ft.

The profile accompanying the report shows 12 of the 25 locks, rising from Lake Erie, and 6 of the 26 locks, descending to the Ohio, as having a lift of 20 ft. each. The rest of the locks would range from 6 ft. to 18½ ft. in lift. These locks would be large enough to pass a vessel 300 ft. in length and 44 ft. beam, with 15 ft. of water over the sill.

The report gives the estimate of cost for the whole canal in detail, with a total cost of $26,375,188. Without going into this detail, the chief items may be presented as follows:

Conneaut Harbor work	$318,080
Excavation and embankment, 43,282,475 cu. yds., @20 cts	8,656,495
53 locks and gates, complete	7,853,434
Weirs and gates at 33 locks	90,000
Draws and drawbridges	480,000
Dams in Shenango and Beaver rivers	397,936
Conneaut aqueduct	144,187
Masonry in arches at Big River, culverts, etc	273,710
380,005 cu. yds. river walls @ $8	3,040,000
Waterways under canal	390,000
Brick revetment, 412,092 lin. ft	550,596
Feeders, gates and weirs	281,360
13 miles 36-in. pipe conduits, laid	357,513
Reservoir dams, weirs and gates	222,500
Right of way and damages	535,460
Ground for storage reservoirs, etc	179,100
3 extra locks on Ohio River	399,600
Engineering and contingencies, 8%	1,953,717

In considering any ship canal project of the importance and dimensions here proposed the question of water supply at the summit level was, of course, carefully studied by the commission. The old Erie extension canal had a summit level of 1,082.5, and the whole water supply was drawn from the Bemus Dam reservoir on French Creek, because of the elevation of this canal no other supply was practically available between the summit and Erie Harbor, 44½ miles from the French Creek supply, nor within 16½ miles south of the entrance of this French Creek supply. Though this supply could have been increased by utilizing the waters of Watson's Run and the headwaters of Shenango Creek, the Commission did not consider the "old" line reasonably practicable, though this line is better than any other lying wholly in the State of Pennsylvania.

The principal engineering works of magnitude on the line of the canal are the cutting north of the Conneaut River (about 1,000,000 cu. yds.) and the aqueduct crossing this river, which, with the cutting, would be 1.5 miles long, and the aqueduct at Big River, 6,000 ft. long in itself. This latter aqueduct, with the cutting south of it, would make 3½ miles of canal, including the handling of about 2,373,000 cu. yds. of material.

In estimating the cost of the canal, the revetment with brickwork of the canal slopes is included, extending from a point 3 ft. above canal water level to a line 3 ft. below this level. The weight of this brickwork, and a stone retaining strip at the lower edge would be about 360 lbs. per longitudinal foot of slope, and the cost would be $1.33 6/10 per foot of canal. Stone revetment, 8 ins. deep on edge and curb 4 ins. thick by 12 ins. deep, would weigh 1,216 lbs. per foot of slope and cost $2.10 4/10 per foot of canal. A revetment of 2 in. plank laid on two longitudinal sills, each 3 × 6 ins., would weigh only 135 lbs. per foot of slope and, if creosoted, cost $1.62 per foot of canal. Clay suitable for brick making is found at various places on the canal line, and coal for burning brick can be had at Shenango for $1.25 per ton. Hence the commission recommends the brickwork.

But as a result of later investigation it is found that in the divide between the waters flowing into Lake Erie and into the Shenango Valley there is a crest which, almost immediately west of the Pennsylvania-Ohio boundary line, sinks quite abruptly into a great plateau, which has a general level of 1,016 ft., or about 65½ ft. below the summit level of the old canal. This plateau covers many square miles in Ohio, and extends eastward far into Pennsylvania. The greater part is wooded, is almost perfectly flat and, in the absence of any improvement, wet and swampy. In this plateau are the principal sources of the Ashtabula, Grand and Shenango Rivers.

Mr. J. M. GOODWIN, in an appendix, locates 9 reservoirs for supplying the summit level, including a pumping station at Shenango, with an aggregate storage capacity of 2,264 million cu. ft., and seven reservoirs storing for lower levels 2,239 million cu. ft. of water. The total storage capacity thus provided is 4,503 million cu. ft. The season of navigation being taken at 214 days, the average daily supply, from storage alone, to the summit level is 10,-

581,366 cu. ft. The total area of territory tributary to the summit is 79,285 acres, or about 124 sq. miles. With 40 ins. of rainfall on this area Mr. GOODWIN counts only upon 15% as secured for storage, though engineers of large experience have assumed 18.4% as capable of being thus utilized. At the rate given, the 79,285 acres would annually afford 1,726,827,300 cu. ft. of storage water, and to this must be added the flow of springs in the bed of Conneaut Lake, gaged, in July, 1890, at 1,512,000 cu. ft. per day, or, in 214 days, 323,568,000 cu. ft. of water. These figures give an annual storage supply of 2,050,395,300 cu. ft., which is practically the same as already assumed for the natural summit storage, and omitting the 214,000,000 cu. ft. which would be pumped (in 214 days) at Shenango reservoir No. 2.

In case of need Conneaut Lake could be lowered from level 1,080 to 1,074. By dikes the lake surface could be confined to 2,000 acres, and the 6 ft. of water mentioned would represent a storage of 522,720,000 cu. ft. When this is added to the total summit storage first given we have 13,023,903 cu. ft. per day for 214 days of navigation, as compared with the 10,581,366 cu. ft. from summit storage alone. The pumping mentioned at Shenango reservoir No. 2 would be performed by water engines driven by the necessary discharge for maintenance of ordinary summer flow in the Shenango River. Mr. GOODWIN next treats of riparian ownership, and of the rainfall and the supply of water necessary for lockage, but lack of space forbids even an abstract of this matter. Mr. T. P. ROBERTS also goes fully into the investigation of the water supply of French Creek, and also of a route to the lakes via the Allegheny River from Pittsburg

The report of 173 8vo pages includes a large amount of statistical matter concerning the probable commerce on such a canal and the manufacturing, commercial and national interests involved. The commission has certainly done its work well, and it only remains for the legislators of Pennsylvania to properly digest the valuable material there presented.

Graphical Determination of Wind Strains in a Tower.

BY CHARLES STEINER.

It may be of interest to readers of ENGINEERING NEWS to see how graphical methods may be advantageously employed to determine strains of somewhat complicated and irregular construction. It is impossible, and not at all intended, by this short description of a strain sheet to explain here in detail the methods of graphical calculation; yet, for all those who are familiar with the elements of graphical statics, a summarized statement will help to understand the diagrams.

Fig. 1 shows the center lines of all members which compose the structure, a tower 240 ft. in height. Fig. 4 shows it in plan. A primary consideration will show that to get maximum wind stresses the wind pressure has to be assumed in a diagonal direction.

For equal pressure per square inch of section, it is obvious that the moments to which the strains in the columns are proportioned are larger for the diagonal direction, the tower presenting then the largest cross-section. We may suppose the moments for both cases equal, taking into account that the same velocity of wind will cause a smaller pressure per square inch of cross-section for diagonal direction than for parallel. In order to get the strains in the columns (approximately), we have to divide them by 1,414 a-b for the diagonal and by 2 a-b for a direction parallel to a-b; hence:

Strain in column for

$$\text{diag. wind} = \frac{\text{Moment (equal)}}{\text{Shorter lever}} = \text{Maximum.}$$

As for the strains in the horizontal struts and in the diagonals, it is obvious again that the shearing stresses, to which they are proportioned, are:

$$\left(\frac{a\,b \times 1.414^2}{2}\right) \div \left(\frac{a-b}{2}\right) = 1.414^2$$

times larger for diagonal than for parallel direction, supposing equal pressure per square inch of cross section.

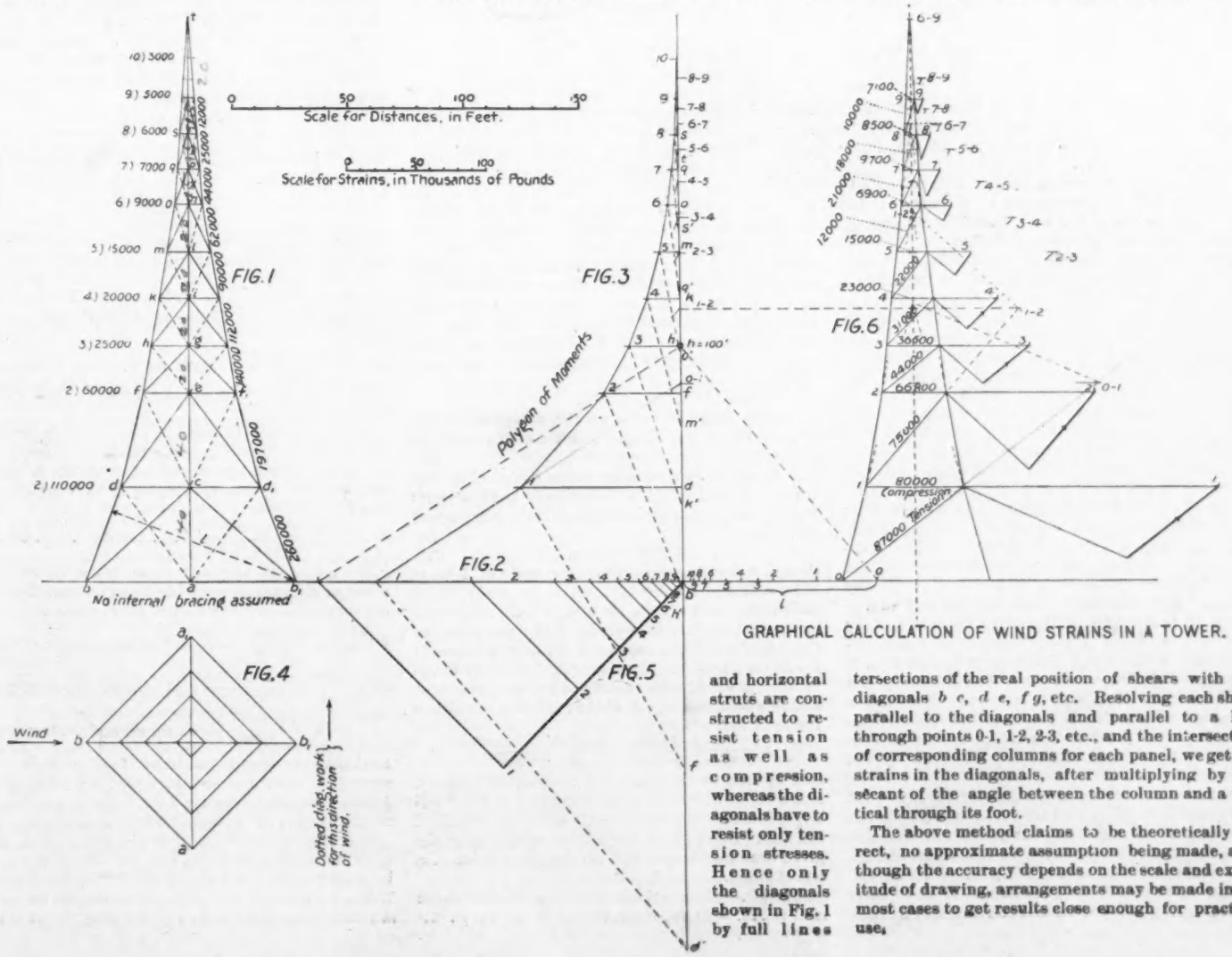
In the following, it is assumed that all columns and horizontal struts are constructed to resist tension as well as compression, whereas the diagonals have to resist only tension stresses. Hence only the diagonals shown in Fig. 1 by full lines will work for wind pressure with the wind blowing, as at b, Fig. 4, whereas the dotted diagonals will come into function when the wind is blowing in the direction $a\,a'$, Fig. 4.

Strains in Columns.—Supposing the roof fastened along the whole line of each column and leaving the intermediate bending moments caused in the panels for a special consideration, we shall have to deal here only with the concentrated wind pressures in the connecting points marked 1, 2, 3, 4, etc., as shown in Fig. 1. The polygon of moments corresponding to these forces is shown in Fig. 3 ($h = 100$). The horizontal lines in d, f, h, k, etc., measured as forces and multiplied by the constant $h = 100$, give moments in those points. After dividing the moments in points b, d, f, etc., by the rectangular distances between $b\,d$ and b^1, $d\,f$ and d^1, $f\,h$ and f^1, etc. (Fig. 1), the desired strains in the columns will result. The multiplication by the constant 100 and the division by the relative levers are performed graphically in Fig. 4, and the vertical distances $b\,d'$, $d\,f'$, $f\,h'$, $h\,k'$, measured as forces, are the strains in the columns $b\,d$, $d\,f$, $f\,h$, etc.; tension in $b\,d$, $d\,f$, etc., and compression in the opposite $b_1\,d_1$, $d_1\,f_1$, etc.

Strains in Struts and Diagonals.—The shear for each point d, f, h, etc., will equal the sum of all concentrated wind pressures above the said points. These shears are shown in Fig. 2 on a horizontal line. Resolving the same into two components diverging 45°, the shear in $b\,a$ and $b\,a_1$, $d\,c$ and $d\,e_1$, $f\,e$ and $f\,e_1$ etc., will result as shown in Fig. 5. Fig. 6 shows the structure projected on a vertical plan parallel to $a\,b$. From the compound shears, shown in Fig. 6 as horizontal lines from the columns to the points 1, 2, 3, 4, etc., the strains in the horizontal struts were determined by the method of moments, taking the moments around the points of intersection of respective columns and in consideration of the real positions of the shears, which are horizontal lines through the points 0-1, 1-2, 2-3, 3-4, etc., shown in the vertical line Fig. 3.

The points 0-1, 1-2, 2-3, 3-4, etc. (Fig. 6.), are the intersections of the real position of shears with the diagonals $b\,c$, $d\,e$, $f\,g$, etc. Resolving each shear parallel to the diagonals and parallel to a line through points 0-1, 1-2, 2-3, etc., and the intersection of corresponding columns for each panel, we get the strains in the diagonals, after multiplying by the secant of the angle between the column and a vertical through its foot.

The above method claims to be theoretically correct, no approximate assumption being made, and, though the accuracy depends on the scale and exactitude of drawing, arrangements may be made in the most cases to get results close enough for practical use.



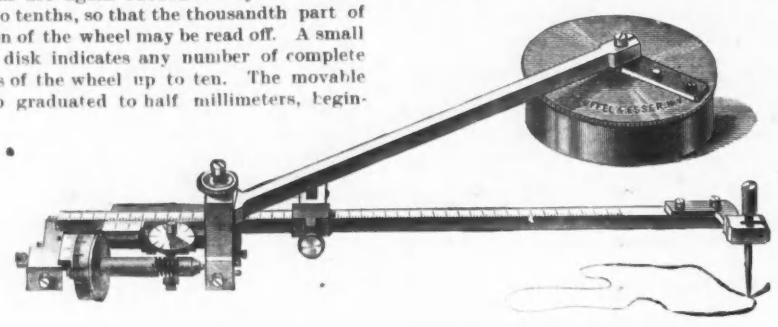
GRAPHICAL CALCULATION OF WIND STRAINS IN A TOWER.

The Polar Planimeter; its Use in Practice.

BY WM. COX.

The polar planimeter is an instrument specially designed for the purpose of ascertaining the area of any plane surface, no matter how irregular its outline, such surface being represented by a figure drawn to any given scale. It ought to be regarded as indispensable in any engineering office, as by it the areas of indicator diagrams, railway and other profiles, plots of ground, sectional areas of ships, areas of displacement of floating bodies, etc., may be quickly and accurately ascertained.

In its most useful and complete form it consists of three principal parts, as shown in the accompanying cut, viz.: The polar arm, which rotates about a fixed fulcrum, composed of a ball joint adjusted to a round brass weight; the movable arm, to one end of which is affixed a steel tracing point, while the other slides in a groove in a carriage, to which the polar arm is also pivoted. The movable arm is by this means capable of revolving in a double sense: either around the joint or pivot, or around the fixed fulcrum, thus enabling the tracer to circumscribe the periphery of any figure whose size does not exceed the limits of the instrument. A small wheel revolves on an axle parallel to the movable arm in bearings in the two branches of the carriage, and is divided on its circumference into a hundred equal parts, which are again subdivided by means of a vernier into tenths, so that the thousandth part of a revolution of the wheel may be read off. A small horizontal disk indicates any number of complete revolutions of the wheel up to ten. The movable arm is also graduated to half millimeters, beginning at the opposite end to the tracer, so that its exact position in the groove of the carriage may be determined by means of a vernier reading to twentieths of a millimeter.



ADJUSTABLE AMSLER'S POLAR PLANIMETER.

If the movable arm were fixed at a right angle to the polar arm, that is to say, at a tangent to the circle which the polar arm describes around its fulcrum, the tracing point would, as it is moved forward in the direction of the hands of a watch, describe a circle, whose radius would be the distance from the fixed fulcrum to the tracer, and during which the wheel would not revolve at all, as its axis would be continuously in the direction of motion. Any divergence, however, from the line of this circle would cause the wheel to revolve, and that in a forward direction if the perimeter of the figure to be measured were entirely outside this circle, and in a backward direction if the perimeter of the figure were inside the circle. If the tracing point were moved backward, the divergencies from the line of this circle would cause the wheel to revolve in opposite directions to those indicated; so that when the tracer follows the contour of any irregular figure, there must of necessity be a combination of forward and backward motions of the the wheel, the graduations of which consequently register their differences, and by a suitable adjustment of the length of the movable arm, and, by assigning a value to each wheel vernier unit proportionate to the scale of the drawing, the area of the figure circumscribed may be obtained by the final reading. This area is equal to the area of a rectangle whose side is the length of the movable arm from the joint to the tracer, and its breadth equal to the length of the arc rolled off by the wheel.

In the simplest form of planimeter, the arm with the tracer is fixed, and its length so adjusted to the diameter of the wheel and the position of the joint that one complete revolution of the wheel always represents an actual area of 10 sq. in. With the aid of the vernier and the graduations of the wheel, inches, tenths, and hundredths of an inch may be read off. This planimeter is specially designed for obtaining the areas of steam engine indicator diagrams, and is not so well adapted to general use as the form here illustrated, both because it is of smaller size and because its scale is not adjustable, so that the area obtained has to be multiplied by some factor.

It will be evident that the shorter the arm from the tracer to the joint the greater will be the arc rolled off by the wheel; or, in other words, the higher will be the number of units registered as the tracer passes over a given distance, and *vice versa*. Herein lies the great value of the planimeter shown in the figure, as by means of the adjustment of the movable arm the area of a figure drawn to *any* given scale may be ascertained, the necessary adjustment for each different one being, when once found, noted for future use by means of the graduations on the arm and the vernier on the carriage.

These adjustments of the arm, or settings, as they are called (equivalent to gage points for the slide rule), may be ascertained by two methods—by computation or by means of a round brass trial disk furnished with each instrument, whose grooved rim incloses a surface of known area (marked on the disk), and around which the tracer can be carried with exactitude. This latter is the simplest and the most reliable, as for the former it is necessary to know with mathematical precision the length of the arm and the circumference of the wheel. Before explaining how these settings are obtained we must say a few words on the values of the wheel vernier unit, to which reference has already been made.

Drawings and plans are always made to a certain scale, such as 1 : 100, 1 in. to 1 ft., 60 ins. to a mile, etc. As any value may be assigned to the unit of the scale to which the drawing is made, so any value may be assigned to the unit of measurement of the planimeter, or wheel vernier unit, in relation to the actual area measured, or to a scale of 1 = 1, which then bears another and different ratio to the scale of the drawing. It is evident that if the instrument indicated lineal measures, this ratio would be expressed by the equation $1 : D \times x = y$, where

D = the scale of the drawing;

x = the absolute value of the wheel unit (the $\frac{1}{10}$ part of a revolution) or its ratio to a scale of 1 = 1;

And y = the comparative value assigned to the wheel unit, or its ratio to the scale of the drawing; but as it measures areas only this ratio is expressed by the equation

$$1 : D^2 \times x = y. \qquad (1)$$

thus, if a drawing were made to a scale of 1 in. = 10 ft. = D, and a valve of 1 sq. ft. be assigned to each wheel unit y, then each such unit registered by the tracer, as it travels along the perimeter of the drawing, would represent an actual value of 1 ÷ 100 = .01 sq. ft. If we now designate by W the number of wheel units registered by the tracer as it makes a complete circuit of the trial disk, we obtain the equation:

$$W = \frac{\text{Area of trial disk}}{\text{absolute value of one unit} = x} \qquad (2)$$

and by trial we find the exact position of the movable arm, at which the given number W of units will be registered while the tracer makes the circuit of the disk. This is then the setting required for the given drawing to scale D, with the given value of a wheel unit y.

Example.—What is the setting for a drawing whose scale is 1 in. = 25 ft., with a value of 10 sq. ft. assigned to each wheel unit, the area of the trial disk being 2,630 sq. mm., or 4.075 sq. ins.?

Here $D = 25$, $D^2 = 625$, $y = 10$;

$$\text{then } x = \frac{y}{D^2} = \frac{10}{625} = .016$$

$$\text{and } W = \frac{4.075}{.016} = 255 \text{ units};$$

that is to say, the wheel must register 255 units while the tracer is moved once round the disk. By trial it will be found with a given instrument that when 9 of the arm is set to zero of the vernier on the carriage that the wheel registers this number of units and if, as stated, each instrument were constructed exactly to the same dimensions, this would be the setting for any one of them for a drawing to a scale of 1 in. = 25 ft., with a wheel unit of 10 sq. ft. Each unit registered by the wheel indicates, therefore, an actual or real area of the figure represented by the drawing of 10 sq. ft.

Required, the area of displacement of a floating body shown on a drawing made to a scale of 1 : 100, with a wheel unit of .05 sq. m.

Here $D = 100$ mm., $D^2 = 10{,}000$ sq. mm., $y = .05$ sq. m. = 50,000 sq. mm.;

$$\text{then } x = \frac{50{,}000}{10{,}000} = 5 \text{ sq. mm.},$$

$$\text{and } W = \frac{2{,}630}{5} = 526 \text{ units}.$$

The exact setting having been ascertained by trial, the tracer is set on the outline of the drawing, and a slight indentation made on the paper to indicate the starting point. Then, after the reading of the wheel and the disk have been noted, it is gently moved round the figure, and when the starting point has been reached the readings are again noted. Supposing the second reading to be 4,355 and the first one 1,668 then 2,687, their difference, is the number of units registered, which, multipled by the unit value y, or .05, gives 134.35 sq. m. as the area of displacement sought.

When obtaining, in the manner indicated, settings for any given scale, it should be endeavored as much as possible that the number of units W to be registered by a trial disk of about 40 sq. ins. should fall between 400 and 600. This is done by giving the wheel unit y a suitable value which may be obtained from Sqs. 1 and 2, by substitution and transposition, so that we have

$$Y = \frac{D^2 \times \text{area of disk}}{W}; \quad \ldots\ldots\ldots \text{ Eq. 3.}$$

thus, to find a suitable value for the wheel unit for a drawing to a scale of 1 : 100, we have

$$y = \frac{10{,}000 \times 2{,}630}{W}$$

We must now select W, so that it may divide the product of the two numerators without remainder, and also that y may be a simple number to multiply by, as 1, 4, 100, etc. In this case the best number coming within our limits is evidently 526, so we have

$$y = \frac{10{,}000 \times 2{,}630}{526} = 50{,}000 \text{ sq. mm.} = .05 \text{ sq. m.},$$

which will therefore be the value of each wheel unit.

It will frequently happen that the same setting will serve for drawings made to different scales by assigning different values to the wheel unit y. These may be found by transposing Eq. 3, from which we have

$$D^2 = \frac{y \times W}{\text{area of disk}} \ldots\ldots\ldots\ldots \text{ Eq. 4.}$$

We now give to y any other value which will allow of the square root of D^2 being extracted without a remainder, and we have, for instance:

$$D^2 = \frac{500 \text{ sq. mm.} \times 526}{2{,}630} = 100 \text{ sq. mm. and } D = 10 \text{ mm.}$$

$$D^2 = \frac{2{,}000 \text{ sq. mm.} \times 526}{2{,}630} = 400 \text{ sq. mm. and } D = 20 \text{ mm.}$$

$$D^2 = \frac{5 \text{ sq. m.} \times 526}{2{,}630} = 1 \text{ sq. m. and } D = 1 \text{ m.},$$

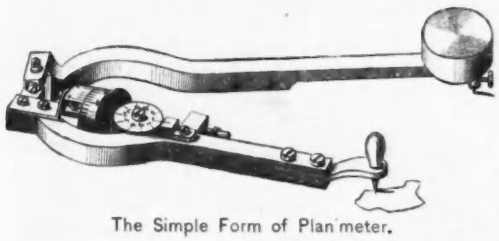
so that the setting found in our last example will serve for drawings to scales of 1 mm. = 10 mm., 1 mm. = 20 mm., 1 mm. = 1 m., with wheel values respectively of 500 sq. mm., 2,000 sq. mm. and 5 sq. m.

The cases so far referred to presuppose that the drawing is of a convenient size for the fulcrum to be placed outside its area, as shown in the figure. When, however, it is of such a size that the fulcrum must necessarily be inside the drawing, then a con-

stant must be found for each setting, which constant represents the area of the circle which the tracer would describe if the movable arm were at a right angle to the polar arm, and during which the wheel would not revolve. This constant has then to be added to the units registered by the wheel as the tracer circumscribes the drawing, in order to obtain the total area. The constant may be found by taking a square of 20 ins. × 20 ins. = 400 sq. ins.; then, supposing it to be the scale, of, say, 1 in. = 5 ft., or 1 sq. in. = 25 sq. ft., with a wheel unit of 0.4 sq. ft., it would represent a real square of 25 × 400 = 10,000 sq. ft., and with a wheel unit value of 0.4 sq. ft. the wheel would, if the fulcrum could be placed outside the drawing, register $\frac{10,000}{.4}$ = 25,000 units.

The final reading of the wheel, obtained by passing the tracer round the square, after the proper setting for the given scale and wheel unit has been adjusted, subtracted from 25,000, gives the constant for the given scale and given wheel unit value. The constant for any other scale may be obtained in precisely the same manner.

It may be interesting here to remark that, when two settings are known, any other setting may be obtained by computation. The method of procedure



The Simple Form of Planimeter.

in this case, as also when no previous settings are known, is very interesting, but the length of this paper forbids our describing it.

From what has been said, it will be seen that the great value of the planimeter with movable graduated arm, lies in its simple and perfect adaptability to drawings made to any scale whatever, for which, by following the instructions laid down, the necessary settings may be very easily and quickly found, and when once ascertained, the reading of the arm and the vernier are noted, so that when the same setting has again to be used, the arm can be at once adjusted to its proper position.

The instrument is applicable to every case where the area of a plane surface is required to be known, whether in surveying, mechanical construction, shipbuilding etc., etc. If this article shall tend to make it more appreciated, its purpose will have been fully realized.

On the Yield of Wells Sunk in Permeable Soils.*

The subterranean flow of water, which forms the supply of wells, is a matter of such complexity that it will be impossible to interpret its principles analytically except by resorting to purely hypothetical assumptions: but it would be useful to have the means of estimating the supply that could be obtained under given conditions.

With this view the author takes the case of a river-basin consisting of permeable alluvial soils resting upon a horizontal bed of some impervious material, whose level coincides with the bottom of the river; and he assumes the underground waters to flow toward the river at right angles to the valley line, and to deliver into each lineal unit of the river channel a certain discharge Q.

According to the experiments of DARCY and DUPUIT, the velocity of this percolating current will be proportional to the inclination of the plane of saturation; and it follows that under the given conditions the surface of saturation will not be a plane but a convex surface, whose section at right angles to the river will be a parabolic curve, the axis of the parabola being coincident with the surface of the impervious bed.

Thus, if z denotes the height of saturation above the impervious bed at any distance x from the river, the velocity of flow will be

$v = k\frac{dz}{dx}$, in which k is a coefficient depending on the permeability of the soil; while at the same time $Q = \varphi z v$, in which φ represents the effective percentage of the interstitial spaces in the mass; whence $x = \frac{\varphi k}{Q}\frac{z^2}{2} + \text{constant}$;

and putting h = the height of water in the river above the same impervious bed,

$$z = \sqrt{\frac{2Q}{\varphi k}x + h^2}$$

The author examines the effect of temporary variations in h and in Q, and having deduced the conclusion that the level of saturation will be only affected very slowly by these changes, he goes on to consider what alttered currents would be set in operation by sinking a well in the permeable bed of the valley at a distance l from the river, the well being carried down to the level of the impervious bed, and the water kept down by pumping to a height h_0 above that level.

The stream lines, which were originally parallel in plan, will now converge toward the well, a certain number of them being intercepted by it, while others are drawn toward the cone of exhaustion, but pass round it and into the river. In the neighborhood of the well the stream lines are nearly radial, and if q is the discharge entering between the two radial lines which inclose the small angle θ, there will result at any distance x from the center of the well, $q = \varphi x \theta z v$; and applying again the same formula $v = k\frac{dz}{dx}$, the inclination of the surface of saturation is given by

$$\frac{dz}{dx} = \frac{q}{\varphi k x \theta z},$$

whence by integration is obtained for the curved form of a section taken radially through the cone of exhaustion—

$$z^2 = \frac{2q}{\varphi k \theta}\cdot \log\frac{x}{_cR} + h_0^2,$$

in which R is the radius of the well.

If the section is taken in a landward direction, running away from the river, the surface of saturation, commencing at the waterlevel in the well, will approximately follow the curve above given for a certain distance, until the stream lines become sensibly parallel instead of radial, or unti the curved surface coincides with the inclination of the original parabolic surface. This takes place at an unknown distance x_0, and to find its value the author proposes alternative analytical and geometric methods. The following expression is then deduced for the maximum supply entering on the landward side, through the small arc θ, viz.:

$$q_a = \frac{\varphi k}{2R}\cdot\frac{H_0^2 + \frac{2Q}{\varphi k}x_0 - h_0^2}{\log_e\frac{x_0}{R}}$$

in which H_0 is the original height of the parabolic surface at the well itself, or the natural level of saturation at that point. But on the opposite side of the well, toward the river, the flow entering through the arc θ will be smaller, and, indeed, may sometimes be a negative quantity. Between the well and the river, the surface of saturation will fall in both directions, and its section will have a summit between those points.

If the distance l is great, and the inclination of the original parabolic surface at the well is small, it may perhaps be assumed that the summit will occur at a distance from the well nearly equal to x_0; and on this hypothesis the minimum flow entering on the lower side is expressed by—

$$q_b = \frac{\varphi k}{2R}\cdot\frac{H_0^2 - \frac{2Q}{\varphi k}x_0 - h_0^2}{\log_e\frac{x_0}{R}}$$

Finally, if the difference between q_a and q_b is not too great, the mean value may be taken as applying to the whole circumference, and the total yield will then be—

$$P = \pi\varphi k\frac{H_0^2 - h_0^2}{\log_e\frac{x_0}{R}},$$

which is equivalent to

$$P = \frac{2\pi Q l}{\log_e\frac{x_0}{R}}\cdot\frac{H_0^2 - h_0^2}{H_0^2 - h_0^2}$$

The author describes some experiments that were made on a small scale to test the value of these deductions. A box 1½ metres by 1 metre was divided into three compartments, the central one being filled with sand, which covered 1 square metre, and which was traversed laterally by a continual percolation of water flowing from a higher to a lower reservoir, the reservoirs being contained in the two extreme compartments which were fitted with apparatus for regulating the head. In the center of the sand area was a well in which the water could be kept down to any adjustable level; and to ascertain the level of saturation at different points, a series of small perforated tubes was sunk in the sand in two rows, one longitudinally and the other tranversely.

The first experiments were concerned only with the direct flow from one side to the other, and served to determine the value of φk, which was found to be nearly constant under varying heads. The well was then put in operation and worked at different levels, the yield being measured and the curve of the surface of saturation noted in each case.

The observed sections of the cone of exhaustion agreed very well with the logarithmic curve deduced by theory. The actual yield of the well was compared with the quantity given by the above formula after inserting the ascertained value of φk, and was found to be always less than that quantity, the actual discharge ranging from 90% down to 43% of the calculated amount. The deficiency is believed to be partly due to the limited scale of the experiment.

A Few Facts about Wire Ropeways, with Notes on the Plomosas Line.*

The system of transporting material by means of the "wire ropeway," or endless traveling wire rope, has been thoroughly tested during the past 18 years, the results proving that a well-constructed ropeway, with the latest improvements, is as sure in its operation as in a railway. It has proved to be cheap in first cost and construction, reliable in operation (not being affected by changes in weather), and most economical in operating expenses and repairs.

The general system of construction is as follows: An endless wire rope is supported at intervals of from 140 to 2,000 ft. on suitable sheaves, which are mounted vertically on the ends of cross-arms fixed to the necessary posts or supporting structures, and at a sufficient height to clear all surface obstructions. At both ends of the line the wire rope passes around sheaves set horizontally. These sheaves are either grip or plain sheaves, as the case may require. Grip sheaves are used where power is to be applied to the rope, or to prevent slipping where brakes are used to regulate the speed, the brake wheel being then attached to the upper side of the grip pulley.

Buckets or carriers of various designs, differing according to the character of the material to be handled, are used. These are suspended by hangers and clips, which are either inserted into the rope or strapped around the outside of it, and are attached at intervals determined by the amount of material to be delivered, calculating the rope to run at a speed of about 200 ft. per minute. The clips are so made that they may pass over the rims of the carrying sheaves and around the horizontal terminal sheaves. The carriers may be loaded at any part of the road, either by the use of an automatic loader or by hand labor, while at the point of discharge the carriers unload automatically, the rope not being stopped either to load or unload.

When the point of delivery is lower than the loading point, and the inclination greater than about one in seven, the ropeway will run by gravity, the speed being regulated by a brake; when less than one in seven, auxiliary power must be employed. A ropeway, running 200 ft. per minute, with ore buckets attached at intervals of 48 ft., carrying 160 lbs. per bucket, will deliver 20 tons per hour. If run by gravity, with a loading device and one man to look after it, one man at the brake and one man at the discharge end, three men can deliver 200 tons of ore, at a cost of about three cents per ton for labor. By using two clips close together on the rope, loads of 500 to 700 lbs. per bucket or carrier can be transported.

THE PLOMOSAS ROPEWAY.

In the year 1884 the author was called upon to construct and put in operation a ropeway for the Plomosas Mining Co., State of Sinaloa, Mexico. Before entering upon this work I had constructed a rope way 4,400 ft. long at Topia, State of Durango, Mexico (it being, by the by, the first ropeway built in Mexico).

After having located the best wooded part of the table land, 2 miles from the mill at Plomosas, a site for the upper terminal was selected in a position which gave the straightest line, together with the shortest spans, and in a district which would supply the mill with wood and charcoal for five years, without going outside of a half-mile radius from the terminal.

The surveys were made by telemeter measurements which, except in cases where grade is very scant and near the limit for a gravity plant, is of quite sufficient accuracy. It may not be uninteresting to mention that the only instrument available was a small mountain transit, which was provided with only one horizontal hair. Two extra hairs were put in, but as there were no ready means for spacing them accurately in the telescope, they were put in without reference to the distance between them, care being exercised only to make them parallel. A rod 9 ft. long was then placed exactly 100 ft. from the instrument, and the space on the rod intersected by the hairs was measured and subdivided into tenths and hundredths. With this graduation the rest of the rod was divided off and painted, being thus empirically graduated to suit the telemeter hairs instead of conversely, as is usually the case. The rod was used as an incline rod, with guide sights for setting it at right angles to the inclination of the line of vision. Notwithstanding the extreme roughness of the ground and the makeshift nature of the stadia device, a survey was made in two and a half days, which subsequent comparison with a

* By FOSSA MANCINI in *Annales des Ponts et Chaussées*, June, 1890, p. 823. Abstracts Inst. C. E.

* Condensed from a paper by B. MCINTIRE before the Technical Society of the Pacific Coast.

triangulation survey proved to be out only 28 ft. in the whole distance (two miles), and accurate to 9 ft. in elevation (in 3,575 ft.).

Having made the requisite surveys and obtained a profile, the first step in order was to locate the carrying structures, which can be done with sufficient accuracy by tracing on the profile arcs of a parabola between the points to be selected for the supports, after having determined upon the tension and necessary sag between sustaining posts. Rules for determining the sag and tension can be found in any standard work on rope transmission.

The Plomosas ropeway was the first to be constructed with so limited a number of available points for sustaining structures and such enormously long spans. The

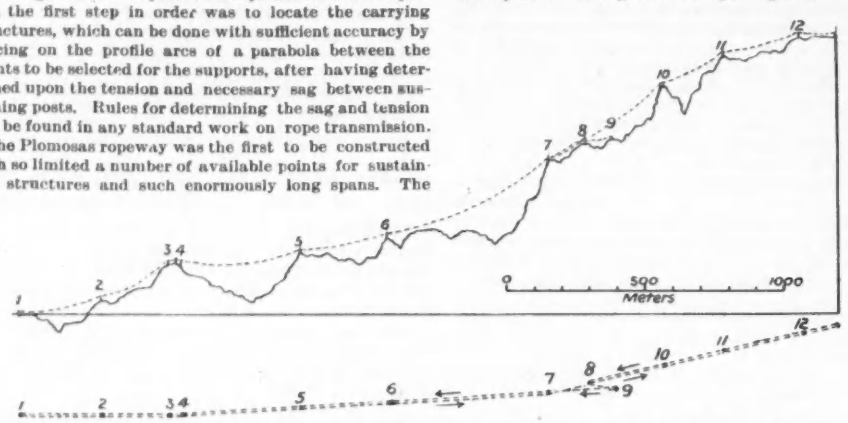


FIG. 1. PLAN AND PROFILE OF PLOMOSAS WIRE ROPEWAY; B. McIntire, Chief Engineer.

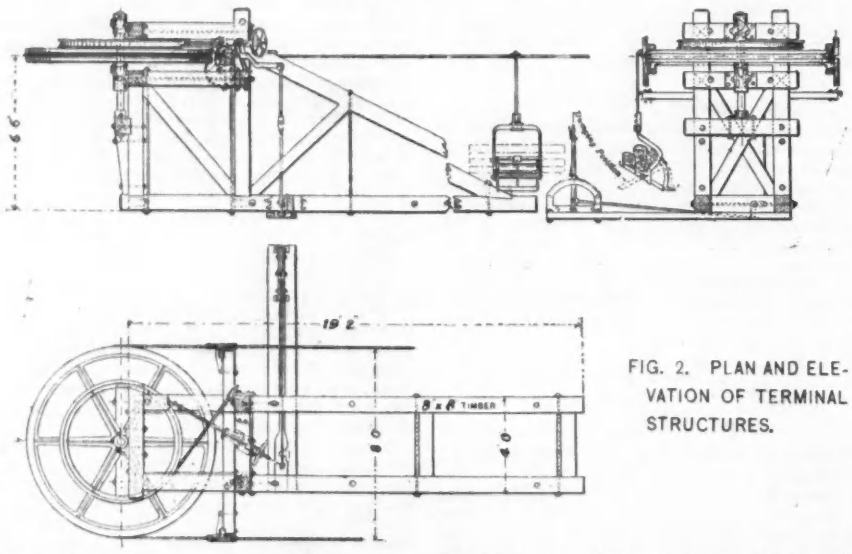


FIG. 2. PLAN AND ELEVATION OF TERMINAL STRUCTURES.

profile, Fig. 1, shows the spans, which (starting with the lower terminal) are respectively 935, 863, 104, 1,378, 977, 1,935, 410, 1 066, 771, 833 and 433 ft.; in all, 9,705 ft. To this length was subsequently added 410 ft. between structures 8 and 9, when the vertical turn sheaves were replaced with horizontal turn sheaves, making a total length of 10,115 ft., with a difference in elevation of 3,575 ft. between terminals.

CONSTRUCTION OF TERMINALS AND STATION STRUCTURES.

As a general rule, hewn timbers have to be used in ropeway construction, as sawed lumber is not available. In some cases round poles are used. These, however, make a very poor structure, and are a continuous source of trouble and expense, taking twice as long to frame as hewn timbers, though employers are apt to think that there is economy in using the cheapest lumber that can be found, not considering the labor and subsequent expense of keeping the line in order. In framing the terminal structures great care was taken to have the work well bolted, and large cast-iron washers were used on the bolts.

The upper terminal structure was made of 8 × 8 in. hewn timbers, and is shown on Fig. 2. The foundation for this terminal was made by digging a trench 45 ft. long × 10 ft. wide × 5 ft. deep. Into this three logs, 24 in. diameter and 40 ft. long were rolled, and upon these, eight cross-ties, 24 in. diameter and 9 ft. long, were placed. These were notched on top to receive the sleepers for the track, which was 4 ft. 3 ins. gage. These sleepers were bolted to the two outside bottom logs; and after everything had been well secured with bolts, lagging was laid on top of the logs between the ties, and the spaces between were filled up with dirt. This made a very solid foundation, and the trees being cut not 20 yds. away, it was the cheapest foundation that could be used.

It is not customary to have the upper terminal mounted on wheels, but at Plomosas there was but 54 ft. run from the lower terminal to the counterweight structure. In fact, no use was made of the top take-up, after it had been put in, as there were opportunities for taking up the stretch of the rope when it was cut to put in the turn sheaves, and later when the splices were renewed, as will appear further on.

CONSTRUCTIONOF INTERMEDIATE STRUCTURES.

In erecting the intermediate supporting structures, use was at first made of such large trees as lay in the direct line of the ropeway, but it soon became apparent that such single post supports were of little use, although some of the trees were 3 ft. in diameter. The vibration at these points was so great that a jerking motion was imparted to the rope whenever a clip passed over a sheave, and the latter began to cut out at the rate of ⅛ in. per week where the single posts were used, although these were braced in every conceivable way, some of them having as many as 12 guy ropes run out in all directions. The supports shown on the profile at the points marked 12, 11, 10, 8 and 7, were all originally of the single post type, but they were all afterward braced by having X-frames built around them, or were replaced by other structures when the line was straightened out and the turn put in. The supports at 6, 5, 4, 3 and 2, were originally built as trussed structures, and gave good satisfaction from the beginning. Fig. 3 shows their construction, which is the best form for use in ropeways with great spans. They are trussed in all directions and are not liable to get out of line, nor will the weighted side of the rope pull the cross-arm out of level. All the bolts may become slack, and still the cross-arm will remain horizontal. In the four-post structure commonly used, the unloaded side of the cross-arm will rise up after a few days' running, often showing a difference of 8 ins. in the level of the sheaves in the course of a week, and keeping a man continually going over the line to tighten up bolts and get the cross-arms back into place. In the truss structures, sills should always be used, as they prevent spreading and keep the whole structure in line. During three and a half years I did not have occasion to tighten a bolt on any of the Plomosas structures.

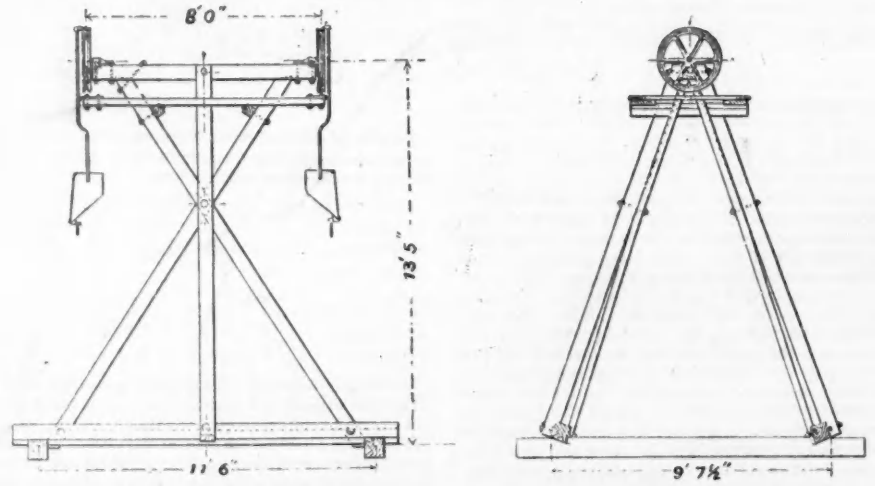


FIG. 3. STRUCTURE FOR INTERMEDIATE SUPPORTS OF PLOMOSAS WIRE ROPEWAY.

THE LOWER TERMINAL.

The lower terminal structure was made of 10 × 10-in. timbers, with 6 × 8 in timber for the track (the length of which was 65 ft.), and supported on 22-in. round timbers for sleepers.

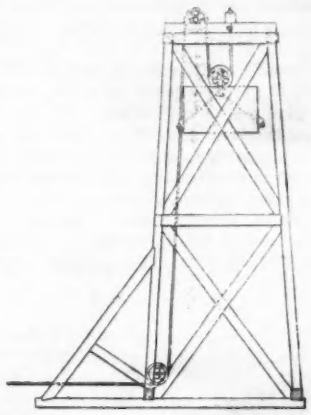


FIG. 4. Counterweight Tower at Lower Terminal.

I erected a four-post tower 24 ft. high to carry the counterweight, as is shown in Fig. 4. On this two sheaves were mounted, one on top and the other at the bottom. To the weight box a saddle carrying a 24-in. sheave was attached, the object being to get a double length of take-up, making 44 ft. in all. This made a substantial structure and worked well, though it was not a structure suitable for general use, as the sharp bends in the rope over the three sheaves are objectionable. When possible, a single sheave should be placed at the top of an incline, down which the counterweight may run.

At Plomosas I let the terminal remain in one position for three or four months at a time without moving it. When the baskets got too near the ground between posts 2 and 3 or between posts 6 and 7, I would run the terminal out four or five feet, which answered quite well.

The movable terminal should have a rail on top of the carriage wheels, to prevent its turning over should the front wheels be raised off the track, as would happen if the rope comes to the terminal at a steep angle from a station above. It is not necessary if the terminal is higher than the post before it, but in all cases it is a wise precaution to have a hold-down rail, as there have been cases where, in starting a ropeway, the terminal has turned over, doing serious damage. Station structures do not need hold-down bolts, except where the rope makes a very steep angle upon leaving the sheaves, and where there is a long span in front of it, which would tend to push the frame back and overturn it. Such a condition would exist at post 7.

TRANSPORTATION OF ROPE.

The transportation of material when it has to be done on pack animals becomes a very serious matter in certain classes of machinery.

The rope for Plomosas was taken in ten pieces, each piece of 2,250 ft. length being carried on seven mules, each carrying 321 ft. with a piece 10 ft. long between each pair of mules, making 70 mules to the train. It required three men to take care of each seven mules.

In coiling rope for mule packing, coils should be made as small as possible, say 24 ins., for when larger it is very troublesome to fasten them to the *aparejo*, or pack-saddle, which gets loose very often, causing much inconvenience when there is a long train. At present freighters will carry rope packed on ten and twelve mules at a slight advance over the regular freight rates, it having now become a common thing to carry such ropes. There are liabilities of damaging the rope by getting kinks in it when not properly rolled and tied or when there is too much slack left between the mules.

When a rope is badly kinked, the wires on the concave side of the kink will soon begin to break. At Plomosas, after the ropeway had been running four months, I had to replace two strands of the rope at points where short kinks had been made in transportation. These had been previously marked, as it was suspected they might give out.*

In transporting the rope to the upper terminal an accident occurred by which three mules were killed. The head mule at a sharp turn in the mountain trail, where a rise immediately followed a steep descent, started up the ascent with a rush until checked by the rope. This threw him backward and over the bank, taking two other mules with him, and had the last of these not caught on a tree, the rest of the train would have followed. The path being cut out of the mountain side, and so narrow as not to admit turning a mule, or even unloading its pack, the coils which had gone over the bluff were fished up, uncoiled, and carried a quarter of a mile by hand. The rope was kinked through this mishap.

PLACING THE ROPE IN POSITION.

The rope used at Plomosas was $^{13}/_{16}$ in. diameter plow steel, of 300,000 lbs. tensile strength per sq. in., and was manufactured by the California Wire Works, of San Francisco, from material brought from Germany. Five of the ten pieces of rope (*i. e.*, 11,250 ft.) were taken to the upper terminal; two pieces were left at post No. 5; two pieces placed between posts 2 and 3, and the spare one was left at the mill.

A temporary horizontal reel was constructed at the upper terminal, upon which I wound, from a turn-table, three of the five pieces, splicing them together as they came. Taking eighteen men I started to draw the rope out on the right hand side of the line, not mounting it on the sheaves as I went, but drawing it along the ground. All went well until post 7 was reached, which took about three hours. I had about 200 ft. of the rope over the bluff, when the end lodged and ceased to run down. I was about to make the rope fast above and go down it to loosen it below, when it suddenly freed itself and dropped, paying itself out from above with a speed that drew fire from the rocks. The man at the brake, having left it to see what was the matter below, reached the brake and stopped it just as the last coils were running off the drum. It would hardly be supposed that a rope laid on the ground, having to overcome the friction caused by running around stumps and over rocks, would start and run of its own accord; but it did, and, when stopped, fully a thousand feet of rope lay in a heap at the bottom of the decline. This I had to turn over carefully, commencing with the first coil, until I had it all disentangled, after which the rope was drawn out without further accident, and what remained on the reel was led off back of the terminal.

The author then describes the process of distributing the remainder of the rope along the line, which was done by moving the temporary reel down to where the coils of rope had been left, at posts 5 and 3, and paying out the rope on each side, afterward splicing the ends to the rope above, already in position. The distribution of the rope was so arranged that the final gap was left between posts 3 and 4. Before making this splice the rope was mounted on all the sheaves except 3 and 4. A manila rope was then attached to each end, and it was hauled taut with a pulley block. At the end of a day the rope had stretched 20 ft., which was due to the heat. This slack was then taken up and the final splice was made. If this had been done at first, 10 ft. of the counterweight travel would have been lost. The rope stretched rapidly during the first month. After that the stretch was inconsiderable.

ATTACHING THE BUCKETS.

The next thing was to attach the clips, hangers and buckets, which were placed 100 ft. apart. On account of the steep grades, this operation required some judgment. Having oiled all the journals and seen that the brakes were in good order, I attached a clamp to the rope. To this clamp was attached a 2-pulley block, having a single-block placed 66 ft. farther out. I hitched the fall of the rope to a mule, and with the help of the men started the rope, having to change the clamp twice for each clip put on.

As the clips were attached to the rope, the baskets were loaded with the heaviest wood procurable. This was continued until the front clips reached post 8, after which, with six men, the rope could be started by pulling upon it. We now discontinued loading the baskets for a while, loading them only when the men had to pull a little hard. With all care, however, it was all we could do to check the speed after the first bucket got over post 3. Having set both brakes up tight, I commenced putting on the clips every 400 ft., until the first basket passed around the bottom sheaves, where they were unloaded. The baskets were next put on in rotation, and we continued to load them when necessary, taking care to have them numbered, and to note which were loaded and which unloaded. After having got the first bucket back to the upper terminal without trouble, missing clips were put on as vacant spaces reached the terminal.

EXPERIENCE WITH BRAKES.

The rope was run three days with light loads, the buckets being only half filled. Then I commenced gradually to fill them, until I found that the two brakes would not control the speed. After running light for a week it was decided to put on another brake on the upper terminal, for which I had already partly provided. Having a bevel gear attached to the grip-sheave shaft in case of necessity, I put in a shaft with a pinion attached back through the frame. On the end of this shaft was put a heavy 36 × 6 in. pulley. This was fitted up with a brake band connected with levers and sufficiently weighted to counterbalance part of the load. This worked excellently and did away with the use of the brake at the lower terminal. It also relieved, though it did not entirely overcome, the rise and fall of the rope caused by having a brake on both terminals of the ropeway, the action of which is to create an accelerating motion, on account of one brake holding the rope fast while the other lets it loose.

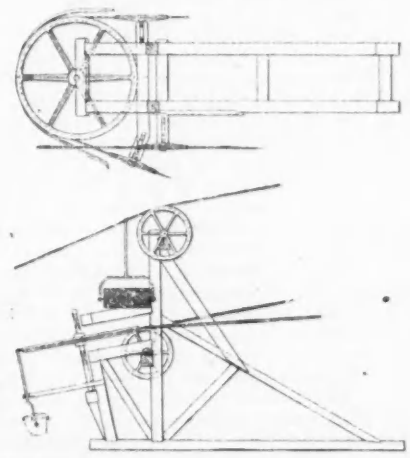


FIG. 5. Plan and Elevation of Horizontal Sheave Structure Built to Replace Post 8.

The brakes were originally provided with hand wheels worked by screws, which is not a good device for regulating the speed. The screw is the worst device for obtaining leverage that can be used on a ropeway brake, as it cannot be adjusted quickly enough. It takes so long to stop the speed that when set the rope will almost stop before the brake can be taken off, and if eased the rope will run away before the brake can again be set. After bothering a year with the hand-wheel brake I connected the brake with levers, which were taken out to one side of the terminal frame at the bottom, the foot lever extending 5 ft. out from the side of the frame. With this the adjustment was quick, and it did away entirely with the accelerating motion of the rope, which subsequently would run for hours at a time without any rise or fall worth mentioning.

HORIZONTAL TURN SHEAVES AND ALTERATIONS IN STRUCTURES.

In making provision for the alignment curve, shown upon Fig. 1, I had been instructed by the manufacturer of the ropeway to use vertical sheaves. The turn was made on three structures, one 12 ft. in advance of post 8, another 15 ft. back of that post. The sheaves were nicely set to the line of the curve, each one taking its share of the load, which was very little, however, coming here, as it did, so near the natural sag of the rope. Under this arrangement the rope on the inside of the curve, which was the loaded side, kept perpetually falling off when least expected. On the off side I put a horizontal sheave in the beginning, and that side gave no trouble. A horizontal sheave could not be used on the inside of the curve, on account of the construction of the clip, which has a projecting arm or shaft attached to the rope.

The author then describes how this difficulty was overcome, which may be easily seen by reference to Figs. 1 and 5. In place of post 8 a structure was built similar to the terminal structures but with a hrrizontal sheave below and a vertical sheave above, as shown in Fig. 5. At post 9 another horizontal sheave structure was erected, around which the rope passed in a contrary direction. Vertical sheaves guided the down rope onto the horizontal sheaves on posts 8 and 9. From post 9 the rope ran to post 7, two small intermediate structures being placed between to carry it over an intervening knoll and allow the buckets to pass where the rope crosses itself in front of post 9. At post 7 the up rope passed around a horizontal sheave and thence straight to the vertical sheave on post 8. It will be seen that by this arrangement all the clips remain on the outer side of the rope in passing around the horizontal pulleys.

While these changes were being made, trusses were set around some of the tree-trunk intermediate stations, and new trusses like Fig. 3 were built to replace others. The rapid wear of the sheaves on these tree-trunk supports, which has been already described, made their continued use impracticable. The author thinks such supports might do for spans of not more than 200 ft.; but he does not recommend their use in any case.

REPAIRING AND SPLICING.

After the rope had been running about two years the splices commenced to give way at the points where the two metal strands are tucked into the rope to take the place of the hemp heart. After repairing a half-dozen places it was concluded to renew the splices entirely. They were all marked, and the clips and buckets near them were removed. The remaining buckets were then loaded lightly. To have replaced all the splices by putting in new short pieces would have taken 22 splices, so 2 long pieces were spliced in, the length of rope at the old splices was cut out, and new splices were made. When new rope is spliced with old the new strands stand out somewhat more than the old ones, and the wear is very rapid. The author continues as follows:

It may appear strange that the wear upon the rope at splices should have been so much greater than elsewhere. A flexible wire rope (19 wires to the strand) can indeed be spliced so that there will be little difference in the wear; but in a rope of seven-wire strands made out of plow steel, at the points just above and below where the two steel strands are inserted into the core and take the place of the hemp heart there is a spot (about an inch in length) where the rope has seven strands instead of six at the circumference. This makes the diameter greater and increases the wear at the splice. Another cause of inequality is that at this point, just below where the steel strands enter the core, there is a length of say 1½ or 2 ins. that has no heart at all. Sometimes an outside strand will crush into this cavity, exposing the other strands to undue wear. In a flexible rope the strands can be set together with a mallett so that the splicing cannot be noticed.

CARE OF CABLE ON WIRE-ROPE WAYS.

The wire cables on ropeways should be kept well lubricated, and tar is commonly used for this purpose. The author used for a year and a half a mixture of Swedish tar and linseed oil, boiled together and applied to the rope once a week. This was found expensive and imperfect. The tar hardened and baked on to the rims of the sheaves, and gave no protection whatever to either rope or sheaves. Afterward continuous lubrication was tried, the mixture being applied to the cable at the rate of about a drop a minute. This worked vastly better, and the sheaves ran 4 months before the tops of the rims had to be trimmed, whereas before this had to be done every month at some points.

The author found, however, that the tar did not penetrate the rope; and he substituted black West Virginia oil for the tar. This decreased the wear on the sheaves, and they ran 6 or 7 months without trimming. The oil penetrated the rope and preserved the hemp core; and during 2 years further use of the ropeway the rope did not show much wear. The author thinks that the heat of the tropical sun had something to do with the poor record of the tar lubricant.

* If a short kink occurs it may be very successfully removed by fastening two clamps to the rope, one on either side of the kink, with just room between to use a mallet freely. Then by unbending the kink in the direction in which it was formed, at the same time twisting the rope with the clamps into proper shape, and setting down with a mallet, the worst kink can be taken out so that it cannot be noticed. Trying to pull or hammer out a kink will only make it worse and weaken the rope more than if it were left in.

The cost of construction of the Plomosas Ropeway was as follows:

Upper terminal	$122.45
Lower "	218.00
Intermediate structures:	
Five trees fitted for posts	103.00
Structure No. 6	369.50
" No. 5	287.00
" Nos. 3 and 4	92.00
Special structure No. 2	105.75
Counterweight tower	169.00
Remodeling structures from post 12 to post 6, including structures to make the turn	332.00
Stretching, splicing and mounting rope and attaching clips and baskets	255.00
Total cost of construction	$2,123.70
Ropeway, material and transportation	15,454.00
Opening and repairing roads	1,822.30
Total for ropeway in running order	$19,400.00

COST OF OPERATING ROPEWAY NINE MONTHS, DELIVERING 5,900 CORDS OF WOOD.

One brakeman	$468.00
Three men filling	702.00
One man dumping	354.00
One man looking after line and oiling	234.00
Oil	117.00
Repairing (very heavy, being $2.25 per day)	526.50
Two men wheeling wood away from terminal	468.00
Two men to receive wood from choppers and deliver it to the packers	702.00
Total	$3,571.50

The cost of delivery of wood by the ropeway and by the methods formerly used was as follows:

During year previous to erecting ropeway 5,100 cords of wood were used, costing at mill $11.25 per cord	$57,371
Labor (handling wood at mill)	3,360
Freight on corn and provisions to wood ranch	1,075
Total	$61,806
During following year 5,900 cords of wood were used, costing $2.20 per cord at upper terminal	$12,980.00
Cost of delivering same by ropeway (as above)	3,571.50
Total	$16,551.50
Leaving a saving for the first year of	$45,254.50

Besides this the ropeway was used for transporting charcoal, lumber, etc., making a total further saving by its use of $7,725. Hence the total saving to the company at the end of the first year, after deducting the entire cost of the ropeway, was $33,579.50.

CLIPS FOR WIRE ROPEWAYS.

The most fruitful source of delays in operating wire ropeways is the slipping of the clips on the rope. The chief source of wear is the contact of the clip with the carrying sheaves. To overcome these evils the author has devised a hinged clip, illustrated in Fig. 6.

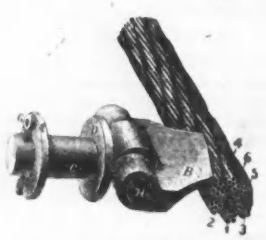


Fig. 6. Improved Clip.

This clip is made in two parts, connected by a pin, thus forming a hinge joint. The body has a web with spiral corrugations, which receives the strands of the rope and are made to conform to the pitch and size of the strands. The other part of the clip consists of a shaft, on which is placed the hanger carrying the basket. By this construction the hinge moves when the clip passes over a sheave, and the rope rides on the bottom of the groove while the clip body rises up on the rim of the sheave. The author finds the following advantages in the use of this form of clip:

The clip being hinged, and inserted into the rope without changing its form at the point of insertion, presents no protuberance on the rope, and allows the clip on coming to the sheave to pass over it without jar to the rope or throwing the load out of its vertical position, and avoids the serious swinging motion occasioned by the use of rigid clips. The hinged form of the clip also admits of the use of deep, wide grooved sheaves, which prevent the rope from "jumping out," as is so apt to occur with the ordinary sheaves in use, the rims of which have to be kept cut down to one-half the diameter of the rope. Besides being readily attached to the rope, this form of clip has the peculiar advantage that it can be easily advanced on the rope from time to time, thus presenting a new portion of the rope to wear and prolonging its life. The clip is not expensive, and it has an advantage over other clips which need heating to bend them round the rope, as this affects the temper of the rope and reduces its ensile strength.

The Sewage Disposal Works of East Orange, N. J.

In July, 1890, Messrs. ALFRED P. BOLLER, HAMILTON WALLIS and J. E. REYNOLDS were appointed a committee by the Town Improvement Society of East Orange, to investigate the charge made that the new sewage disposal works were a failure, and to report upon the actual working of the system. This report, under date of Feb. 2, 1891, has been published, and following is an abstract of its contents:

This was the first works of its kind built in this country; but it was no experiment, as ample precedent existed abroad, and it was highly endorsed by American experts. While its execution was put into the hands of a young man, the committee say that the fact that not more mistakes were made is strong testimony to the natural ability of the engineer in charge.

The collecting system is one of small pipes, from which all storm water is excluded and the groundwater is theoretically excluded. The requirements were thus perfect laying and joints impervious to water. The early failure of the contractor for this part of the work, threw the burden of pipe laying on the township, which preferred to carry it out by pay roll, instead of letting to new contractors. There are now 28 miles of these sewer pipes laid, but much of it is in water bearing quicksand, and the investigations of the committee showed that it was not wholly tight.

Since July, 1889, the disposal works have operated under the intelligent supervision of a sewerage engineer, who devotes his whole time to it, and troubles incident to previous lack of this constant care have been eliminated. The amount of sewage matter treated is from 1,200 house connections, plus 1,250,000 galls. in 24 hours from the discharge of flush tanks. There are two sets of precipitation tanks, with three tanks to a set, which are used alternately and hold 180,000 galls. at one filling; the filling usually taking about 3½ hours. From gagings made by the committee, just after two days moderate rain, the sewage flow to the works was found to be 1,375,000 galls. in 24 hours; and an average was deduced of 1,250,000 galls. They also figured that the Orange Water Co. supplied 500 galls. daily, as an average, to each of the 1,200 sewer connections, or 600,000 galls. in 24 hours. To this must be added about 30,000 galls. from 21 automatic flush tanks, making a total of 630,000 galls. as the probable legitimate work of the sewage system with present connections. Deducting this from the average delivery at the works, we have about 700,000 galls. daily as the leakage of ground water into the pipe system, from imperfectly laid pipes.

The sewage water enters the disposal works through a rectangular channel, with alternate projections on the sides to break and retard the flow. At this point the sewage is treated with one barrel of lime and 300 lbs. of alum, to the quantity named, at a daily expense of about $6. The sewage then passes to the set of settling tanks and finally, passing first through a coke strainer, emerges upon the filtering ground. The final effluent is delivered in a brook in the form of apparently pure water. The detail of this plant is described and illustrated in ENGINEERING NEWS, Jan. 19, 1889. The filtering field covers over 20 acres, and is underdrained by tiles 5 to 6 ft. under ground. The three coke beds now used are about 5 ft. deep, 50 ft. long and 6 ft. wide. The report says that owing to the retentive nature of the soil, and the depth of the drains, the downward filtration here cannot be regarded as successful, and the coke beds are essential for the proper working of the system.

The committee procured analyses of the water as discharged from the coke filter and final effluent. Prof. A. R. LEEDS reported that in the first specimen he found a large amount of unoxidized sewage. But in the analysis of the final effluent into the brook, Professor LEEDS says the benefit of the treatment becomes apparent, and the nitrogenous organic matter almost entirely disappears, the free ammonia being only one-fortieth and the albuminoid ammonia only one-ninth of the quantity showing in sample No. 1. The disappearance he ascribes to oxidation in its passage through the ground. He says that the sewage impurities have been effectually removed and the substances remaining are such as are found in country streams in their natural unpolluted shape; and Professor LEEDS adds that this effluent is far less dangerous than the water of the Passaic River at the Belleville pumping station, supplied to Jersey City.

The committee gives the following financial statement regarding the operations of the disposal works:

Disposal plant cost	$95,847.80
Other construction	322,020.64
Total	$417,868.44

In the above, $20,749.20 represents real estate. The maintenance of the disposal works alone, excluding pipe lines entirely, cost:

From July 9 1888, to Feb. 28, 1889	$3,935.63
From March 1, 1889, to Feb. 28, 1890	8,950.14
From March 1, 1890, to Jan. 2, 1891	8,814.63
Total	$21,700.40

Or, when averaged by months, it cost $562 per month in 1889; $746 in $1890, and $881 in 1891.

The committee finally concludes that the sewage disposal system is a success and is working satisfactorily, and that it can be made to serve the needs of a much larger population than the township now contains. But the committee is also of the opinion that ultimately it will be found economical to dispose of the sewage by gravity to tidewater, by united action with adjacent towns. The maintenance of a local system, like that in use in East Orange, is a constant and increasing annual cost; whereas a gravity disposal costs practically nothing to operate.

Legal Decisions of Interest to Engineers.

Release of Railway Company from Construction Damages.—Where the owner of land which abuts on a street has released, for a valuable consideration, a railroad company from all damages resulting from the construction and maintenance of its railroad in such street, he cannot afterward maintain an action against the company to enjoin it from changing its track from a narrow to a broad gage. (Denver U. & P. v. Tooney, Sup Crt. of Colorado, 25 Pac. Rep. 166.)

Necessity of Specifications in Advertising for Bids.—The provision in a statute or charter that public contracts shall be let to the lowest responsible bidder necessarily implies that the bids shall be measured by a common standard in order to ascertain which is the lowest, and therefore the bids must all be submitted on the same specifications. Bids for city work submitted on specifications prepared by each bidder do not rest upon a common basis of comparison, and are illegal, as they tend to render it impossible to determine who is the lowest bidder. (Mazet v. City of Pittsburg, Sup. Ct. of Pennsylvania, 20 At. Rep., 693.)

Obstruction of Private Way by Railway.—Where one has the established right of way over land, although it is not a public highway, he has a right to maintain his title to it as against a railroad company, and the latter is bound to construct its road so as preserve that title, and permit the use of the private way. Although the statute providing for condemnation refers only to real estate, yet the same remedies will apply to easements, and an action for damages as for trespass cannot be maintained but the remedy is by obtaining compensation as for land taken by condemnation. (Ross v. Georgia C. & N. Ry. Co., Sup. C. of South Carolina, 12 S. E Rep., 100.)

Rule of Law Relating to Low Bridges.—In an action to recover damages for injuries sustained by a brakeman who was struck, in the night time, by a "low bridge" while he was riding, in the performance of his duty, on the top of a freight train, the fact that he had several times passed under the same bridge in safety in the night time is not at all conclusive that he was negligent when injured. The proof must be that he was negligent on the specific occasion of the injury sued upon. To determine whether the company was negligent in not erecting "whipping-straps" as signals to warn brakemen of the proximity of low bridges, the inquiry is not whether the device is serviceable, but whether it is so manifestly serviceable as to command the consensus of intelligent railroad men so generally as that it cannot be reasonably ignored or disregarded. An instruction that plaintiff is not guilty of contributory negligence unless he had "knowledge" of the location of the bridge is erroneous, as notice of its existence sufficient to put him on inquiry as to its location is all that is required. (Louisville & N. Ry. Co. v Hall, Supr. Ct., Ala., 8 South Rep. 371.)

Negligence in Care of Turn-Tables by Railway Company.—Where a railway company leaves its turn-tables unfastened, and the managing agent of the company has his office near the turn-table and constantly sees children playing on it before the accident, the fact that he tied the table with a rope so that it could not be revolved unless the rope was cut or untied, does not relieve the company of liability for its negligence in not adopting secure means to prevent so dangerous a machine from being revolved by children likely to be attracted by it. (Iiwasco Ry. Co. v. Hendrick, Supr. Ct., Wash., 26 Pac. Rep., 335.)

Violation of Speed Ordinance by Railway Co.—In an action to recover damages for the death of a person killed by a railroad train, alleged to have been run at a higher rate of speed than that limited by law, the testimony of a witness who saw the train, that it was running at a speed of 18 to 20 miles an hour, is competent. Such an opinion does not necessarily involve scientific knowledge, and one who possesses such a knowledge of time and distance is perfectly competent to express such an opinion. The opinion of one who has never timed a moving train is not of as much value as that of one who has, but that is a question as to the weight which shall be given to the opinion and not as to the right to express one. Where the injury done was occasioned by the cars leaving the track, some connection must be shown between the unlawful rate of speed and the injury, and even though there is nothing to connect the derailment with the undue speed, the fact that a train under heavy headway will, upon leaving the track, go further and do more damage than would a train run within lawful speed is enough to connect negligence in that regard with the injuries resulting from derailment. (Walsh v. Mo. Pac. Ry Co., Sup. Ct. of Mo., 14 S. W. Rep. 873.)

Notes On English Railways.

(Continued from p 243.)

LONDON, BRIGHTON & SOUTH COAST RAILWAY.

This railway does not serve a manufacturing district, and its business is mainly in passenger traffic. It has a very large suburban traffic around London, and a considerable long distance regular passenger traffic, such as that between London and Brighton. At the latter place, on the coast, 50 miles south of

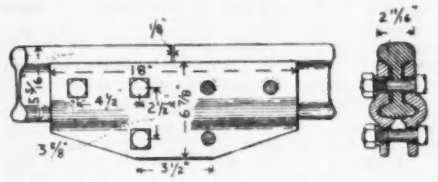


Fig. 20. Rail Joint, 84-lb. Rail; L. B. & S. C. Ry., England.

London, many wealthy business men reside, and special fast trains for their accommodation are run up in the morning and down in the afternoon. A large proportion of the passengers have season tickets. In the summer there is a heavy passenger and excursion traffic with the several seaside resorts on the line. The company has established a harbor at Newhaven, and runs a line of steamers thence to Dieppe, 64 miles, in connection with trains to Paris on the Western Railway of France. The railway system has a total length of 481 miles. It comprises three or four different routes from London to the south coast, with several cross country lines, and a coast line about 80 miles long between Hastings and Portsmouth. The principal routes from London are to Brighton, 50 miles; to Portsmouth, 86 miles; to Newhaven, 56 miles; and to Eastbourne and Hastings, 65 and 75 miles.

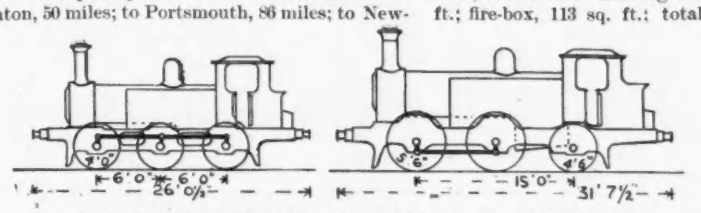


FIG. 21. TANK ENGINES; L. B. & S. C. RY., ENGLAND.

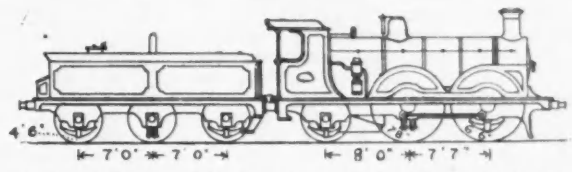


FIG. 22. EXPRESS ENGINE; L. B. & S. C. RY., ENGLAND.

Track.—The main lines are laid with steel bull-head rails weighing 84 lbs. per yd., carried in cast iron chairs. The present standard form of chair has a base of 8¼ × 15 ins., and weighs 45 lbs. Each chair is secured to the tie by 3 hollow trenails and 3 iron spikes, the spikes being driven into the trenails. The older chairs are narrower and lighter than those generally used on the northern railways, and some of them are wider under the rail than at the ends. On the London local line from Addison Road to the Crystal Palace the chairs in some places have 2 fastenings on the inner side and 1 on the outer side of the track, while in other places there are 2 on the outer and 1 on the inner side. At frogs and switches larger chairs are used, with 2 fastenings on each side of the rail. The rails are laid with square suspended joints, spliced by plain splice bars and 4 bolts with button heads. The heads of the bolts are on the inner side of the rail and the washers and square nuts on the outer side. The wooden keys are on the outer side, and the jaw of the chair has a sharp vertical rib which cuts into the key and prevents it from working loose. During a trip over the line to Newhaven the joints were found to be very perceptible. A form of bridge joint which is used to some extent is shown in Fig. 20. The splice bars give the rails a base support for a length of 18 ins., and are kept tight to the base of the rail by the two ⅞-in. bolts through the lower webs. Four track bolts are used in the usual way. The inner splice bars have a ledge to prevent the square heads of the bolts from turning. The rails are laid with square joints.

Locomotives.—This road has 410 locomotives. Each engine driver has his own engine, and in the cab are painted the name of the driver, the different dates at which the engine has been sent out from and returned to the shops for repairs, etc., and the mileages made between these dates. In 1871, the late Mr. STROUDLEY, Locomotive Superintendent, brought out a small type of tank engine with 6 wheels, all coupled, which is shown in Fig. 21. A number of these engines are in regular service, and can haul local trains of 16 cars. Their leading dimensions are as follows: Cylinders, 13 × 20 ins., inclined 1 in 11; wheels, 47½ ins. diameter; wheel base, 12 ft.; boiler, 42 ins. diameter, with 125 tubes 1⅝ ins. outside diameter and 8 ft. 3¾ ins. long. Heating surface: tubes, 473 sq. ft.; fire-box, 55 sq. ft.; total, 528 sq. ft. Grate area, 10.3 sq. ft. Working pressure, 140 lbs. The side tanks carry 500 galls. (595 U. S. galls.) of water, and the bunker 1,120 lbs. of coal. The weight in working order is 18,368 lbs. on each axle, or a total of 55,104 lbs. A somewhat heavier class of side tank engine was afterward brought out, which is also shown in Fig. 21. These engines are extensively used in local service. They have cylinders 17 × 24 ins.; four leading coupled wheels, 66 ins. diameter, and a single pair of trailing wheels 54 ins. diameter. Most of the passenger engines are of types very common on English railways, having a single pair of driving wheels and a single pair of leading and trailing wheels, or 4 coupled driving wheels and a single pair of leading wheels. Trucks are not used on the engines. In 1883, Mr. STROUDLEY brought out a new type of engine for heavy express service, known as the "Gladstone" class, in which the four leading wheels were coupled and a pair of small trailing wheels was placed with the axle under the rear end of the fire-box. This was a new departure for express engines, although the arrangement had been extensively adopted with tank engines on several roads. This type is shown in Fig. 22. The dimensions are as follows: Cylinders, 18½ × 26 ins.; driving wheels, 6 ft. 6 ins. diameter; trailing wheels, 4 ft. 6 ins. diameter; boiler, 53 ins. diameter; driving wheel base, 7 ft. 7 ins.; total wheel base, 15 ft. 7 ins. Heating surface: tubes, 1,373 sq. ft.; fire-box, 113 sq. ft.; total, 1,486 sq. ft. Grate area, 20.65 sq. ft. Weight on leading wheels, 30,912 lbs.; on driving wheels, 32,480 lbs.; on trailing wheels, 23,296 lbs.; total weight, 86,688 lbs. The cylinders are inclined, and have the slide valves placed underneath. The leading axle has plate springs, while the driving axle has coiled springs. The tender is carried on 6 wheels, 4 ft. 6 ins. diameter, and the middle axle has coiled springs. It carries 2,250 galls. (2,698 U. S. galls.) of water, and 4,480 lbs. of coal, and weighs when loaded 61,600 lbs. There are squeeze brakes on the coupled wheels, and brake shoes on the rear side of the tender wheels. Some engines have a steam jet for applying sand under the leading driving wheels, and in some cases the tender has a sand-box behind the tank, with pipes leading down behind the trailing wheels. A small lamp is sometimes placed under the boiler against the smokebox, just over the motion, to facilitate oiling, etc., at night. The Westinghouse brake is applied to the driving wheels and throughout the train. The engines have a very bright appearance; the boiler, cab, wheels, splashers, tender, etc., are a bright yellow ochre, with black, olive green and red striping; the frames are a dark plum color, with red and yellow striping; the dome is either of brass or painted yellow; the smokebox and smokestack are black, and the latter has a copper top. The engines are usually named and carry the name in brass letters on the tank or the wheel splashers.

Rolling Stock.—This road has several Pullman cars, and runs some solid vestibuled Pullman car trains. The cars were built in the United States, shipped in sections, and put together at the railway company's shops. They are carried on four-wheel trucks, having 42-in. wheels and a wheel base of 9 ft. Some of these cars are lighted by electricity. The ordinary passenger rolling stock consists principally of four and six wheel cars with four or five compartments each. The second class cars are very comfortably upholstered in gray cloth, and have a handsome interior finish in natural wood; the roof and the partitions above the padding being of polished teak planks, forming panels extending the whole width of the car, and having gilt moldings. The color of this wood is a rich, red brown, which looks very well with a high polish. The cars have generally wheels with a solid wood filling, and Mansell retaining rings, but the guards' vans or brake vans, or baggage cars have generally iron spoke wheels. Electric lighting has been adopted for some trains, the dynamo in the baggage car being driven direct from one of the car axles, and accumulators being used to supply the current when the train is standing. Oil lamps are still generally used, however, and are very unsatisfactory, giving a miserably poor light. The lamp being generally in the middle of the roof of the compartment, gives the light at a disadvantage for reading purposes. The suburban and local trains are almost entirely made up of short four-wheel cars, coupled very closely together with a middle coupling and buffer, and two safety chains. The cars are only uncoupled when repairs are required. These trains look at a little distance like one long articulated car. The cars being so close together, the brake pipe is continued along under them, as on American trains, instead of being led up vertically at the end of each car and connected with the rubber hose. These cars are 26 ft. long, 8 ft. wide, 6 ft. 10 ins. high inside, and 12 ft. high from the rail to the top of the lamp cover. They are carried on 4 wheels 43½ ins. diameter, and have a wheel base of 15 ft. One of the second class cars is shown in Fig. 23. First class: 4 compartments, seating 8 persons each, or 32 passengers in all; padded seats and backs, and arm rests between the seats; weight, empty, 15,680 lbs. Second class: 5 compartments, seating 10 persons each, or 50 passengers in all. The middle compartment has 1 lamp, the other 4 compartments have 2 lamps between them, placed in the partition in the attempt to light 2 compartments with one lamp; weight, 15,540 lbs. Third class: same seating capacity as the second class; wooden seats with low backs up to level of the window sills, and no partitions; between each 2 doors is 1 window, 34 ins. wide, instead of 2 windows. There are 2 or 3 lamps to the car. At each end of these trains is a "brake van" of the same dimensions. They have 3 third-class compartments without partitions and lighted by 1 lamp, and a rear compartment about 10 ft. long for the

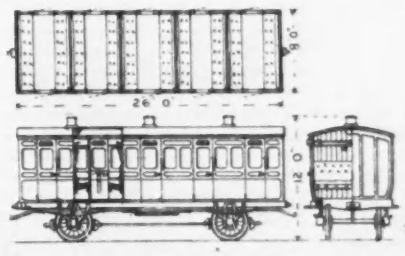


Fig. 23. Second Class Suburban Car; L. B. & S. C. Ry., England.

"guard" or conductor and for baggage. At the rear end of this compartment the sides are extended about 6 ins., giving a 4-in. window through which the guard can see along his train. The weight is about 16,828 lbs. The Westinghouse brake is used, with brake shoes on all the wheels of 4-wheel cars and on the 4 outer wheels of 6-wheel cars. Instead of the communication cord all trains are fitted with electrical intercommunication. In each compartment is a knob, by pulling which the passenger can give an alarm to the conductor and engine driver. When the knob is pulled a small disk is displayed at the side of the compartment and the knob cannot be pushed back, so that the alarm can be easily located. The outside of the cars is finished in polished teak, which has a very fine effect. The sides of brake and baggage cars are formed of wide planks reaching from the floor to the roof, with vertical

molding strips over the joints. The frames are of teak, with the outer sides polished, and the iron work of buffers, steps, horn plates, etc., is painted bronze green. The handles and hand rails are of brass, and the lettering and striping are gilt. At a meeting of the company in January, 1891, it was stated that the line carried in 1890 about 500,000 fewer first-class passengers, 1,000,000 fewer second-class passengers, and 7,000,000 more third-class passengers than it did 10 years ago. The suggestion has been made, as on many other lines, to abolish the second-class, but as there were 2,815,000 passengers in that class in 1890, the idea is not approved by the company. In spite of the growth of third-class traffic, however, many of the fast trains have only first or first and second class accommodation. On the other hand, during the summer months there are numerous very cheap third-class fast excursion trains to the seaside.

Steamers.—The company's steamers running between Newhaven and Dieppe are fast sidewheel boats, well built and fitted with good engines. The passenger accommodations are unsatisfactory, and the remarks on page 243 in reference to the steamers of the Great Eastern Ry. apply equally to this line. The cabins are below the main deck, and their ventilation is so bad that in a short time after sailing the atmosphere is foul enough to cause nausea. The second-class cabins or saloons are small and inconvenient, and the passengers spend the night on open shelves or bunks fitted with mattresses. Separate cabins are provided for ladies. E. E. R. T.

[*To be continued.*]

PIG-IRON PRODUCTION has declined rapidly since Dec. 1, 1890. At that time there were 340 furnaces in blast, with a capacity of 183,800 tons per week. Now, according to *Iron Age*, there are only 257 furnaces in blast, with a capacity of 134,500 tons per week. The labor troubles in western Pennsylvania and Ohio are probably only partly responsible for this, since the anthracite and charcoal furnaces are reported to have added to their stocks on hand and the coke furnaces carry nearly as much stock as they did a month ago.

THE TOTAL OUTPUT OF BASIC STEEL throughout the world during the last year was 2,602,000 tons—2,232,600 tons by the Bessemer and 370,400 tons by the open-hearth process. This is an increase of 14.4% over the production in 1889. The American percentage of this large output is very small, as shown in another column.

AN ELECTRIC HOISTING AND CONVEYING MACHINE, the invention of EZRA NICHOLSON, of Cleveland, O., has been in operation during the past few weeks in Cleveland, with results said to be successful. A 30 HP. Rae electric motor is mounted upon a light tram car holding suitable hoisting mechanism, and the operator, riding on this car, hoists the load from any desired point and conveys it to the place of unloading. The presence of the operator, always over his work, is claimed to be a decided advantage over the steam automatic cable systems. The present work performed by the plant is unloading a vessel of iron ore, hoisting a load of 3,000 lbs. vertically 5 ft. per second and traveling across a bridge 30 ft. high and 200 ft. long, spanning the ore dock, the cross travel being made in 10 seconds, and the operator stopping the car, holding the bucket, and dumping the load at any desired point.

PROFIT-SHARING has been very successfully worked by the Ingersoll Rock Drill Co. for two years. As a result of the operations of the year 1890 an employees' dividend of about $6,000 has been declared. This sum is considerably in excess of the amount divided at the close of the year 1889, owing to the large increase in the company's business during the past year.

THE HEADINGS OF THE CHAPLINE HILL TUNNEL, at Wheeling, W. Va., met on March 13. The tunnel is 2,664 ft. long, and is to be used by the Wheeling Bridge & Terminal R. R. The work has been done in 15 months by Paige, Carey & Co., under the supervision of Mr. M. H. SMITH, of Altoona, Pa.

THE LINE-OF-BATTLE SHIP Royal Sovereign, launched last month at Portsmouth, England, is said to be the largest warship ever constructed in that country. Her dimensions are: Length, 380 ft.; breadth, 75 ft.; draft, 27½ ft.; displacement, 14,150 tons; indicated horse power, 9,000 with natural and 13,000 with forced draft. Her forced speed is to be 17½ knots. The Italian battleships Sardegna and Italia approach nearest her in size, with 13,850 and 13,690 tons respectively.

PERSONALS.

Mr. HENRY H. CARTER has been appointed Superintendent of Streets at Boston, Mass.

Mr. MILES F. BRENNAN has been elected President of the Water Board of Lowell, Mass.

Mr. CHARLES KELLOGG, Civil Engineer, and President of the Kellogg Tube Works, died at Findlay, O., March 13, aged 75 years.

Mr. EPES RANDOLPH has been appointed Superintendent and Chief Engineer of the Newport News & Mississippi Valley R. R., with office at Lexington, Ky.

Mr. GEO. J. HARTMAN has been appointed Superintendent of the Western division of the Atchison, Topeka & Santa Fe R. R., from Dodge City, Kan., to Denver, Colo., vice Mr. W. A. DRAKE, resigned.

Mr. JAMES HAYES has been appointed Supervisor of Subdivision No. 2, Cleveland & Pittsburg division of the Pennsylvania Co., with headquarters at Ravenna, O. He succeeds Mr. S. W. SAMPLE, resigned.

Mr. ROBERT F. MUSHET, the English metallurgist, who did much to make a commercial success of the Bessemer steel process, died in January at Cheltenham, England, aged 80 years. A certain make of steel is known as Mushet steel.

Mr. E. H. MCHENRY has been appointed Principal Assistant Engineer of the Northern Pacific R. R., vice Mr. H. S. HUSON, resigned to accept the position of Chief Engineer of the Wheless Underground Electric Ry. Co., of Washington, D. C.

Dr. GEORGE BAIRD, of Wheeling, W. Va., who was recently shot and killed by another physician, was a member of the City Water Board and of the American Water-Works Association. One of his sons, Mr. GEORGE BAIRD, Jr., is Secrerary of the Water Board.

Hon. VIRGIL POWERS, of Macon, Ga., has been appointed Railroad Commissioner of Georgia, vice Mr. J. W. ROBERTSON, resigned. Mr. POWERS is an engineer, and was at one time Principal Assistant Engineer of the Southwestern R. R. of Georgia. From 1876 to 1888 he was General Commissioner of the Southern Railway & Steamship Association.

Hon. WARNER MILLER, President of the Nicaragua Canal Construction Co., accompanied by a party of engineers and capitalists interested in that enterprise, sailed for Greytown, Nicaragua, via Jamaica, by the steamer Aguan on Saturday last, with the intent of making a careful personal inspection of the route. After passing over it to the Pacific coast, visiting all important points of the line en route, the party will take a Pacific Mail steamer for Panama, and thence return to the United States after a total absence of about six weeks. Mr. D. MCN. STAUFFER, of this journal, accompanies the party, and from him, on his return, our readers will doubtless learn how the enterprise looks on personal inspection.

Mr. WM. G. DOUGLASS, for many years engineer of the Baltimore & Ohio R. R., died in Virginia, March 15, aged 72. His first service was on the preliminary line for the Alexandria & Orange R. R., now belonging to the Richmond & Danville system. He made the first survey for the Manassas Gap R. R., from Manassas to Strasburg, Va., and the preliminary survey for the Rockfish Gap tunnel through the Blue Ridge for the Chesapeake & Ohio R. R. He was civil engineer on the Baltimore & Ohio road, under Chief Engineer LATROBE, of the Hancock division. In 1851 he was division engineer on the Central Ohio R. R. from Wheeling to Columbus. He then formed a copartnership, under the firm name of Douglass, Smith & Co., and contracted for building all the cars and bridges of the Central Ohio and other roads. In 1872 he was division engineer on the Atlantic & Lake Erie R. R., in Ohio.

NEW PUBLICATIONS.

—*Preliminary Survey and Estimates.* By THEODORE GRAHAM GRIBBLE, Civil Engineer, London and New York; Longmans, Green & Co. 12mo, pp. 420; 133 cuts, 68 tables. Well indexed. $2.25.

The first impression in taking up this volume is, how very much more tasteful and appropriate it is typographically than are most of our American text-books. There are a few, a very few, exceptions; but in the main our American scientific publishers seem to vie with each other in issuing tasteless and inconvenient volumes, especially in padding out their works by thick and much sized paper, broad margins and large type, with the apparent object of gaining an excuse for charging a higher price for the book. Not that they thus give to their publications anything of the air of an *édition de luxe;* far from it. The volume is merely made clumsy and ugly, since little attention is paid to style and proportion in this padding. On the other hand, few English scientific publications reach our table which are not about what they should be in respect to paper, type, engravings and general appearance; while we rarely see evidence of that abominable practice to which we have alluded, a fact the more curious because in non-technical publications the contrast is the other way. The volume now in question is not very tastefully bound, but the interior leaves little to be desired typographically.

When we come to the contents of such books of English origin, however, we are by no means able to speak with such cordial approval of most of them. Even when, as in the one now in question, there is an evident purpose to adapt a work to the requirements of "the whole Anglo-Saxon race," and to especially advocate certain features of American practice, the proverbial difficulty of serving two masters becomes apparent; neither one is as well served, as he otherwise might have been, by an undivided allegiance.

Something of this difficulty is apparent in Mr. GRIBBLE'S treatise, and yet true science is one the world over, and the book has many good points about it, which will, in fact, serve to make it acceptable to young engineers on both sides of the water, though for American practice it contains much which will be of little use.

To illustrate by beginning at the back end of the book, no less than 86 of its 420 pages are devoted to "Instruments," which is quite too much space proportionately. The American engineer cares little or nothing about any other instruments than a plain transit (with stadia attachment and gradienter screw, perhaps) and a Y level. The "dumpy level" and "theodolite," which are described in much detail in this work, are mere historical antiques which he neither knows nor cares about. A great variety of other instruments are described in this chapter, some of them excellent, and which ought to be more known and used; but as they are not so used (at least in this country), it would seem as if an instrument maker's catalogue or special circulars, rather than a general text-book, was the place to describe them.

The volume opens with some "General Considerations" as to the laying out of railway routes, largely abstracted from, and credited to, Mr. WELLINGTON'S treatise, but with considerable additional matter as to constructive details. The next chapter is on "Route Surveying or Reconnaissance," which includes some careful directions as to the use of the plane table for such purposes, and a simple explanation which will be useful to many of the principles of small scale mapping.

A chapter of 25 pages on "Hydrography and Hydraulics" follows, which is necessarily somewhat sketchy. Each of the two subdivisions of the chapter could hardly be covered adequately in a volume. The next chapter of 42 pages on "Geodetic Astronomy" is very good. It will alone be worth the price of the book to engineers wanting such details in compact form without having to begin from the foundation and make themselves astronomers. The next chapter on tacheometry, or quick measurement without chaining, is also excellent. The chapter on "Curve Ranging with Transit and Chain" (which is preceded by a short chapter on chain surveying) is an attempt to make known to English engineers American practice in running curves, and hence is not likely to be specially useful to Americans. The method of keeping the field notes there shown is not the best nor most approved. Some useful data as to spirals or transition curves for both railways and tramways are included in this chapter.

The next chapter is one on "Graphic Calculation for Preliminary Estimates," and it will be found suggestive by all engineers. It is the longest chapter of the book, and one of the most useful, a special feature being illustrations of the extent to which a good slide rule can be made practically useful, which re-enforces what has been lately said in these columns on that subject. The long chapter on Instruments, which we have already noticed, closes the volume proper; but we may further mention that in it is described a really admirable instrument, called the "ideal tacheometer," designed by the author, and which we judge to have many points of excellence. The author is a strenuous advocate for decimal subdivision of the degree, and in this we fully agree with him.

An appendix contains a variety of trigonometric, transition curve and specific gravity tables, and closes with a really admirable glossary, chiefly (but by no means wholly) of astronomical terms. As a whole, we can heartily commend the work as one from which the young engineers (and some of the old ones) will derive many useful hints.

—*An Argument against Government Ownership of the Railroads of the United States.*—Various good reasons given why National Control of the Railroads is a Better Policy and More in Harmony with Republican Institutions than Government Ownership. Statistics showing that the railroads are not fairly dealt with by a part of the public, who favor anti-railway legislation; together with suggestions as to needed reforms in the methods adopted for regulation of the railways; facts about the railways of this and foreign countries, and other informa-

tion of value. By J. KINDELAN, Mitchell, S. Dak. 16 mo. pp. 118; 25 cts.

The long title to this small volume gives so clear an idea of its contents as to make a summary unnecessary. We cannot attempt a critical review of the argument.

—*Report of Committee on Water Supply, Manchester, Mass.* SAMUEL KNIGHT, Chairman. Pamph., pp. 34.

Subjoined to the report proper of the committee is the report of their Engineer, Mr. PERCY M. BLAKE, Hyde Park, Mass. Mr. BLAKE recommends a filter well or gallery near Sawmill Brook as a source of supply, with pumping to a stand-pipe.

—*Inaugural Address of J. B. Sargent, Mayor, New Haven, Conn.* Jan. 1, 1891. Pamph., pp. 28.

This address is notable because it contains a discussion of the comparative desirability of public as against private ownership of natural monopolies, as the following quotation will show:

I believe that all works of a public nature, carried on mainly within the bounds of a municipality, and for the purpose of supplying the inhabitants with certain daily requirements of civilized city life, and requiring special rights of eminent domain to distribute their products, should be owned and operated by the people and in the sole interest of the people.

Mayor SARGENT supports the above by stating that the services mentioned are practically monopolies shutting out all competition, and giving rise to profits which should more properly "go to the people themselves," the only customers of the works, to be used in the payment of the indebtedness incurred in procuring the works, or in reducing the price of the product. He urges that public ownership of such works would remove one of the most constant promoters of impurity in local elections—the use of money by private corporations to secure the election of men who will favor their schemes.

The address touches on other questions of public policy, as grade crossings, parks, and cheap and efficient means of local transportation.

—*Annual Reports, Worcester, Mass.* C. A. ALLEN City Engineer. Pamph., pp. 470; illustrations.

This pamphlet contains the reports of the city engineer and the committee on and superintendent of sewers. The chief interest centers in that part of the city engineer's report in which he describes the purification plant. A great part of this matter, including a general plan and details, appeared in our issue of Nov. 1, 1890. In addition to the illustrations given in ENGINEERING NEWS the report contains reproductions of two photographs, one a general view of the precipitation tanks and adjoining buildings, the other a view showing the tanks in more detail, and the manner of delivering the sewage into each tank.

The following quotation from City Engineer ALLEN'S section of the report is very interesting:

As a practical illustration of what is accomplished, samples of the sewage and of the effluent, taken at the same time, have been saved. Sewage, five months old, is the color of ink, and the odor from it is so foul that it is sickening; while the effluent of the same age is clear, colorless and entirely without odor. I am perfectly satisfied that no decomposition takes place in the effluent, and that, so far as the Blackstone River is concerned, it is as unobjectionable as spring water would be.

Mr. ALLEN states that where the inverts of sewers have been reconstructed of concrete there has been no deposit, and refers to a section 4,000 ft. long that has been in use 9 years, with absolutely no deposit, and so no cleaning during that time.

—*Annual Reports.* Receipt is acknowledged of the following city engineer's and general city reports:

Rockland, Me., O. H. TRIPP, City Engineer; Burlington, Vt., A. H. DOW, City Engineer; Arlington, Mass., T. Roden, Superintendent water-works; Pawtucket, R. I., A. R. SWEET, Engineer of Sewers; Waterbury, Conn., R. A. CAIRNS, City Engineer; Danville, Pa.; Atlanta, Ga., W. P. Richards, Superintendent Water-works, Sioux Rapids, Ia.

—*Report of the Department of Public Works, San Diego, Cal., for the year* 1890. T. M. SHAW, City Engineer. Pamph., pp. 32.

This report contains prices paid during the year for bituminous rock paving and for porphyry macadam. The price for the former on rock base was 22 cts. per sq. ft. for paving proper, 88 cts. per lin. ft. for granite curbing, and 24 cts. per sq. ft. for granite gutters. The porphyry macadam cost 15.85 cts. per sq. ft. in one locality and 17 cts. in another. Superintendent of sewers, S. T. GOLDTHWAITE, states that of 400 inspection holes, made of double Ys, there are 284 "so constructed that a view of the sewer can only be had with the aid of light reflected from one or two mirrors, or by lowering a lighted candle," and he adds that even such means are unavailing for the 116 remaining inspection holes. Mr. GOLDTHWAITE also states that the flush tanks connected with the sewers, which are of the Field-Waring automatic type, have given much trouble, which repeated cleaning and attention has not obviated. In September last it was demonstrated that but few of the tanks were working automatically, and since that time it has been found that of the 61 tanks in use not more than two or three could be depended upon to flush without personal attendance. Therefore, one man was constantly employed during the latter part of the year to visit and flush the tanks. It is stated that this work may require the service of another man, unless the defects in the tanks can be remedied, which, says Mr. GOLDTHWAITE, is not probable.

City Engineer T. M. SHAW refers to the lack of records in his office, owing to the fact that previous engineers were employed irregularly and considered notes and maps made by them as private property. San Diego is not the only city, we regret to say, with a lack of such records.

SOCIETY PROCEEDINGS.

Civil Engineers' Club of Cleveland.—The eleventh annual meeting was held March 10, 37 members and 5 visitors being present. The following officers were elected: President, J. L. Gobeille; Vice-President, N. E. Rawson; Secretary, A. H. Porter; Treasurer, N. P. Bowler; Librarian, C. M. Barber; Directors, F. G. Osborn and S. J. Baker. The retiring officers presented their reports. Among the reports of committees were the following: Surveying and Civil Engineering, by Prof. C. L. Saunders; Mechanical Engineering, by Mr. W. Muller; Some Recent Discoveries in Astronomy, Prof. C. S. Howe. A revised constitution was adopted.

American Society of Civil Engineers.—At the meeting on March 18, Vice-President Fteley in the chair, Mr. John Thomson, M. Am. Soc. C. E., read a paper on "A Proportional Water Meter, specially adapted to inferentially measure the Total Discharge of Nozzles." The method of measuring was practically similar to that suggested by Mr. Freeman in his paper on "The Nozzle as a Water Meter," read at the meeting on Feb. 18, but using a water meter instead of a pressure gage, as being more reliable for piezometric measurements. A water meter of the positive displacement rotary type was recommended. Mr. John C. Trautwine, Jr., in discussing Mr. Freeman's paper, stated that the use of the nozzle is simply a special case of the general case represented in the Venturi meter as developed by Mr. Herschel, and in Pitot's tube as developed by Prof. S. W. Robinson. He considered Mr. Thomson's suggested proportional or inferential meter to present some advantages, and hoped he would give a practical test. It would be of interest to establish piezometers at points close together along the nozzle and play pipe. The subject was further discussed by Mr. Fteley, Prof. Denton, Mr. Nash and Prof. Webb, the latter of whom described methods of measuring the force of a jet. The general impression shown by the discussion was that the weir method of measurement would still be the best for measuring the discharge of large pumping engines.

New York Railroad Club.—At the meeting on March 19, about 50 were present and 17 new members were elected. Mr. G. W. West was elected a member of the executive committee in place of Mr. Wm. Buchanan, resigned. It was voted that amendments to the rules of interchange be the special order for the meeting on April 16. A paper by A. E. Hunt, President of the Pittsburg Reduction Co., on "The Prospects of the Use of Aluminum in Railroad Work," was read by the Secretary.

Among the important prospective uses noted were for quick moving valves, where its lightness would decrease the retardation due to the inertia of the valve, for the framework of semaphore signals, for reflectors, for locomotive headlights and for art and decorative work. The aluminum alloys, especially the bronze, promise to be of more importance in railway work than pure aluminum. Most of the data given by the author were contained also in his paper read before the Boston Society of Arts, published in ENGINEERING NEWS of Feb. 28 and March 7.

A paper on "Pressed Steel in Railroad Work" was read by Mr. Chas. T. Schoen, of Pittsburg, President of the Schoen Mfg. Co. The paper was discussed by Mr. D. L. Barnes, of Chicago, consulting engineer of the Fox Solid Pressed Steel Co., and others. About 12,000 tons of pressed steel has been put in service on railway cars within the past three years, and its use is rapidly increasing. The principal obstacle in the way of its introduction is the great diversity in sizes and shapes called for by railway mechanical officers, for each one of which a set of dies must be made. For center plates alone the Schoen Mfg. Co. has over 70 sets of dies. The use of pressed steel is increasing fast, however, in spite of these obstacles, and the success of all-steel cars and their early use may now be expected.

The next meeting will be held on April 16.

Engineering Association of the South.—The regular monthly meeting was held at Nashville, Tenn., March 12. President John B. Atkinson in the chair, and about 20 members and visitors present.

President Atkinson announced the following appointments for the standing committee on highways, comprising one member from each state represented in the association: Mr. J. R. Carter, Birmingham, Ala.; Mr. B. T. Burchardi, Fernandina, Fla.; Mr. A. V. Gude, Atlanta, Ga.; Mr. E. L. Corthell, Chicago, Ill.; Mr. C. O. Bradford, New Albany, Ind.; Mr. John MacLeod, Louisville, Ky.; Mr. J. Kruttschnitt, New Orleans, La.; Mr. W. Starling, Greenville, Miss.; Mr. Wm. Stickney, Buffalo, N. Y.; Capt. W. H. Bixby, Wilmington, N. C.; Mr. S. Whinery, Cincinnati, O.; Mr. E. C. Lewis, Nashville, Tenn.; Mr. C. W. Richardson, Richmond, Va.

The president extended an invitation to the association to hold its May meeting at Earlington, Ky., which is in the heart of the western coal field, and the invitation was accepted. In addition to the technical subjects to be discussed at that time, President Atkinson promised to controvert many of the principles established by Isaac Walton, and to give on that occasion ocular and experimental proof of the correctness of his criticism.

The paper of the evening was entitled "Mine Inspection," by Mr. C. J. Norwood, Kentucky State Inspector of Mines. The paper presented an exhibit of the present status of the 91 coal mines in the State of Kentucky which are subject to state inspection, not only as to the general character of the mines, but also as to the character of the ventilation and the use of safety appliances. Mine inspection was first introduced into Kentucky in 1884, the law at first, however, being quite imperfect. At present ventilation by natural means is prohibited; fans are used at 16 of the mines and ventilating furnaces at the remainder; 100 cu. ft. of air per min. per man is required to be delivered in each section of every mine in the state. Headings and entries are not allowed to be opened more than 60 ft. in advance of air. The mine law requires safety catches to be maintained on all cages and imposes a fine of $5 per day per cage for each day's failure to comply with the law after due notice. Fire damp has been found in only 10 mines and explosions have resulted therefrom in only 2 of these. Since 1884, 48 fatalities have occurred, of which 28 were caused by fall of roofs, 6 by blasting, and 3 by dust explosions. Maps of the workings of each mine are required to be filed at the office of the inspector twice each year. Mr. Norwood states that there has been a very general and willing compliance on the part of mine owners and operators with the provisions of the mining law and that a sentiment is being very rapidly developed in support of the closest inspection and rigorous enforcement of all safety precautions.

New England Railroad Club.—At the meeting on March 11 the annual election of officers was held, resulting in the choice of the following: President, F. M. Twombly; Vice-President, Jno. T. Chamberlain; Secretary and Treasurer, F. M. Curtis. The discussion of the subject for the evening, "Screw Stay Bolts for Locomotives," was opened by Mr. J. N. Lauder. He gave the reasons for the use of higher pressures in boilers now than in former years and ascribed the troubles with stay bolts to the unequal expansion of the fire-box plates when the engine is working hard at high pressure. Under these conditions circulation is defective and the plate next the fire is heated much above the temperature of the water in the boiler. The breaking of the stay bolt is due to the continual bending back and forth as the plates expand and contract, which gradually crystallizes the metal. The bolts in variably break close to the outside sheet; hence the nearly universal practice at the present time is to perforate the stay bolt from the outside for an inch or so. But these little holes are apt to become clogged with dirt and grease, so that steam will not escape even when the stay bolt is broken off. Hence they should not be too implicitly relied on for safety. The common method of testing a bolt is to place a sledge over it and tap this lightly with another sledge. An expert boilermaker can tell to a certainty whether the bolt is entirely broken; but if the bolt is only partly broken, and half or even a quarter of its cross-section is still intact, the test will not show it.

To meet the gradual increase in pressures, Mr. Lauder has enlarged his stay bolts to 1 in. diameter, and he spaces them not over 4 ins. apart. Boilers so stayed are running under 170 lbs. pressure. Many years ago, when boilers carried only 110 lbs. of steam, ¾-in. stay bolts spaced 6 ins. apart were used and answered very well. In present practice stay bolts begin to give out after about 6 years' service, and it was suggested that all the stay bolts in the boiler might be removed after a certain number of years, not over 8. To set stay bolts nearer together than 4 ins. would hardly do any good, as the breaking is not due to tensile stress. Referring again to the need of frequent testing, Mr. Lauder said he was requested over a year ago by the Massachusetts Railroad Commission to test all stay bolts every three months and report. He objected, considering it an unnecessary expense and trouble. Since then, however, he has seen the benefit of it, and would not now abandon the practice under any consideration.

Mr. Angus Sinclair believed that the increase in steam pressures was making boiler explosions more common than formerly. Higher pressures should cause increased vigilance in inspecting stay bolts. A boiler which can get along all right with a number of broken stay bolts at a low pressure may let go if the pressure is run up 30% or more. He favored drilling and frequent inspection as a means of preventing accidents. A fairly soft iron with a high limit of elasticity was the best material, but stay bolts of large diameter had greater stress by bending than those of small diameter, and so it was injurious, rather than beneficial, to increase the size beyond that needed to resist the tensile stress. Mr. J. T. Gordon said his practice was to require 1¼-in. stay bolts for the five top rows.

At the meeting on April 8 the subject will be, "Air Brakes for Freight Trains, their Care, Condition and Efficiency," to be opened by Mr. Angus Sinclair.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—March 21. Secy., Howard Murphy, 1122 Girard St.
Denver Society of Civil Engineers.—March 24, "Underground Surveying." Secy., Geo. H. Angell.
Western Society of Engineers.—April 1. Secy., J. W. Weston, 230 La Salle St., Chicago.
Engineers' Club of St. Louis.—April 1. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
American Society of Civil Engineers.—April 1, "Cable Railways." Annual meeting, May 20, at Lookout Mt., Tenn. Secy., Francis Collingwood, 127 E. 23d St., New York.
Engineers' Club of Minneapolis.—April 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Technical Society of the Pacific Coast.—April 3. Secy., O. von Geldern, 408 California St., San Francisco.
Association of Civil Engineers of Dallas.—April 3. Secy., E. K. Smoot, 803 Commerce St.
Northwest Railroad Club.—April 4. Secy., H. P. Robinson, St. Paul, Minn.
Civil Engineers' Society of St. Paul.—April 6. Secy., C. L. Annan.
Civil Engineers' Association of Kansas.—April 8. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—April 8, "Air Brakes for Freight Trains." Secy., F. M. Curtis.
Engineers' and Architects' Club of Louisville.—April 8. Secy., G. W. Shaw.
Northwestern Track and Bridge Association.—April 10. Secy., D. W. Meeker, St. Paul, Minn.
Engineers' Club of Duluth.—April 11. Secy., M. W. Lewis.
Engineers' Club of Kansas City.—April 13. Rooms, Baird Building. Secy., H. Goldmark.
Civil Engineers' Club of Cleveland.—April 14. Secy., A. H. Porter, 50 Euclid Ave.
Engineering Association of the South.—April 14. Secy., Dan H. Landreth, Vanderbilt University, Nashville, Tenn.
Engineers' Club of Cincinnati.—April 16. Secy., J. F. Wilson.
New York Railroad Club.—April 16. Rooms, Gilsey House. Secy., H. G. Prout.
Western Railway Club.—April 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.
Engineers' Society of Western Pennsylvania.—April 21. Secy., S. M. Wickersham, Pittsburg, Pa.
Boston Society of Civil Engineers.—April 22. Secy., S. E. Tinkham.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July-December, 1890), is now in press, and will be issued about April 15, in a separate small volume handsomely bound in cloth, which will be sold at $1. It will prove a valuable work of reference even for those whose files are not complete.

THE new constitution for the American Society of Civil Engineers, which has just been adopted, makes some very important changes in that organization, most of which seem likely to result in good, though some of them are of questionable expediency. The changes in the membership grades are very desirable. The qualifications for full Member are considerably increased, 5 years', instead of 1 year's, responsible charge of work being required, and an age minimum of 30 years being fixed. A wise proviso accepts service as a professor of engineering as an equivalent for active practice, though not for responsible charge of work.

On the other hand, the qualifications for the grade of junior are considerably lowered, and the new grade of associate member introduced between those of member and junior, which will make it much easier to fulfil both of the more or less antagonistic objects of the society—viz., to extend its advantages to all engineers of good character (which implies easy admission), and to maintain "a high professional standard among it members," which implies rigid scrutiny of candidates. Both members and associate members are alike styled "corporate members," with absolutely equal rights and privileges except in the distinction of name. All the other grades (associates, juniors, fellows, and subscribers, a somewhat needless number) can neither vote nor hold office.

The process of electing members is also somewhat modified. There must be, first, the present ballot, but requiring 7 instead of 5 negative votes to exclude, and secondly, the present second ballot if demanded, but with the important modification that the negative votes must be 10 per cent. of all cast to exclude. This practically means that the Board of Direction will decide on the admission of all candidates, as in the Institution of Civil Engineers, and it might perhaps as well be so in form as it is in fact. The Board of Direction is hereafter to elect all non-corporate members without the formality of ballot or even of prior notice of candidacy through the so-called "blue list."

THE governing body of the society is almost absurdly enlarged. The number of directors is increased from 5 to 18; of vice-presidents from 2 to 4, and all living past-presidents (of whom there will be 12 next year) are made directors for life, so that the Board is increased from only 10 members, or one of the smallest in existence, to 37, or much the largest. The quorum still remains only 5, however, as before, and hence it is likely to be even easier than before for two or three members to "run" the Board, if they care to take the trouble, for it is well known to be easier to "run" large boards than small ones, since what is everybody's business is nobody's business. The Nominating Committee is increased to 12, 7 appointed as now, and the 5 last living past-presidents *ex officio*.

The secretary and treasurer remain, as now, members of the Board, which is to be regretted, and there are some queer provisions in regard to the office of treasurer, which must have come about by accident, since when analyzed they are somewhat absurd. The secretary remains, as heretofore, the practical treasurer. He is to "see that all moneys due the society are carefully collected, and without loss transferred to the custody of the treasurer;" and he is to "carefully scrutinize all expenditures," and "personally certify the accuracy of all bills and vouchers," and "countersign all checks." This alone seems to leave merely formal functions to the treasurer. Nevertheless, that officer, as well as the secretary, "shall be" paid a salary, and that salary "shall not" be reduced "during his term of office," which would seem to make it difficult or impossible to legally reduce it at all, since no Board has jurisdiction over the affairs of the society beyond its year of office. Moreover, in addition to specifying that an assistant secretary shall assist the secretary in the above duties, there is to be an "auditor," who "shall have entire charge of the books of account of the society," and furnish monthly statements and balance-sheets. To check the auditor, there is to be an "expert accountant," who "shall" examine the books and accounts yearly, and who does not ordinarily work for nothing; and, finally, there is a Finance Committee, which "shall have" supervision of the "accounts and financial affairs" of the society, and "approve all bills" before payment. In view of these multiplied provisions for guarding the funds, the query cannot but arise: Wherein lie those arduous duties of the treasurer, which make it necessary to stipulate that he "shall have" a salary, which may be increased but shall not be diminished? In the Institution of Civil Engineers, with over five times the revenue, the treasurer is simply "a banker in the city," and the Am. Soc. C. E. has a like functionary in its service, in addition to the list above.

THE recent celebration of the manufacture of basic steel at Chattanooga was an event of more importance than the usual run of mutual-admiration gatherings. It has long been known that our Southern ores, with the exception of those from the Cranberry district in North Carolina, and possibly a few other localities, contain so much phosphorus that they are unsuited for producing the best acid Bessemer steel, and so much silicon that the basic Bessemer process also partially failed. The basic patents were controlled by Pennsylvania parties, and it has been stated, on very uncertain authority however, that they threw all possible obstacles in the way of the Southern promoters of the process. Be that as it may, it is probable that the furnace that started up at Chattanooga on Sept. 16, 1889, is only a forerunner of many large plants like it throughout the South.

This seems to be indicated, at least, by the following table, which is interesting as showing the rapid spread of the basic process abroad. It must be borne in mind, however, that the greater part of this steel was made in converters, 83¼ per cent. in 1890, while our American ores are probably best adapted for open-hearth treatment.

The basic steel produced in this country thus far has been of excellent quality, and with better facilities it is probably destined to overcome the slight prejudice against it that now exists. In 1888 more than one-fourth of the coke pig produced in Germany was used in basic converters or furnaces; and with such an example before them it is not unlikely that the Southern metallurgists will soon convince all doubters of the error of their ways.

Progress in Manufacture of Basic Steel, in Thousands of Tons.

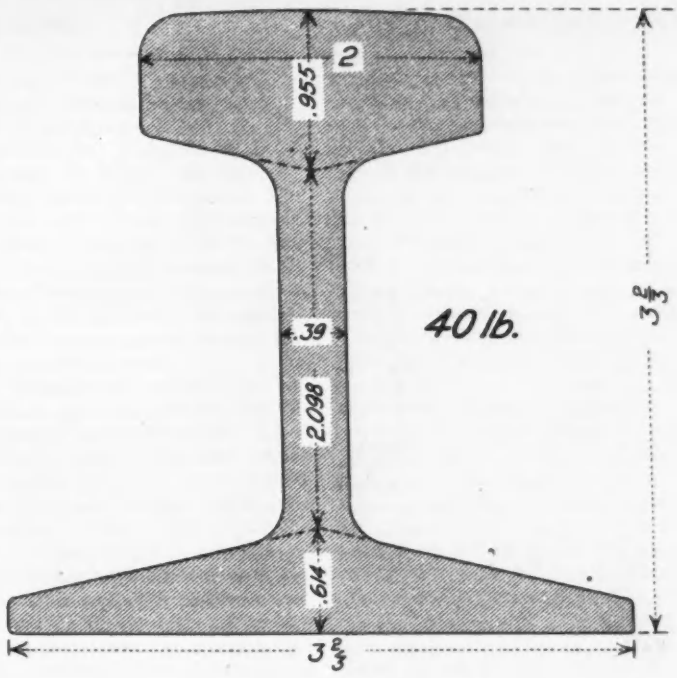
Total output in	1887.	1888.	1889.	1890.	Per cent. increase in 4 years.
England	365	499	494	503	37.8
Germany, Luxemburg, Austria	1,102	1,276	1,482	1,695	53.8
France	177	222	222	240	35.6
Belgium, Russia, United States	61	46	77	164	168.9
Total	1,705	1,953	2,275	2,602	52.7

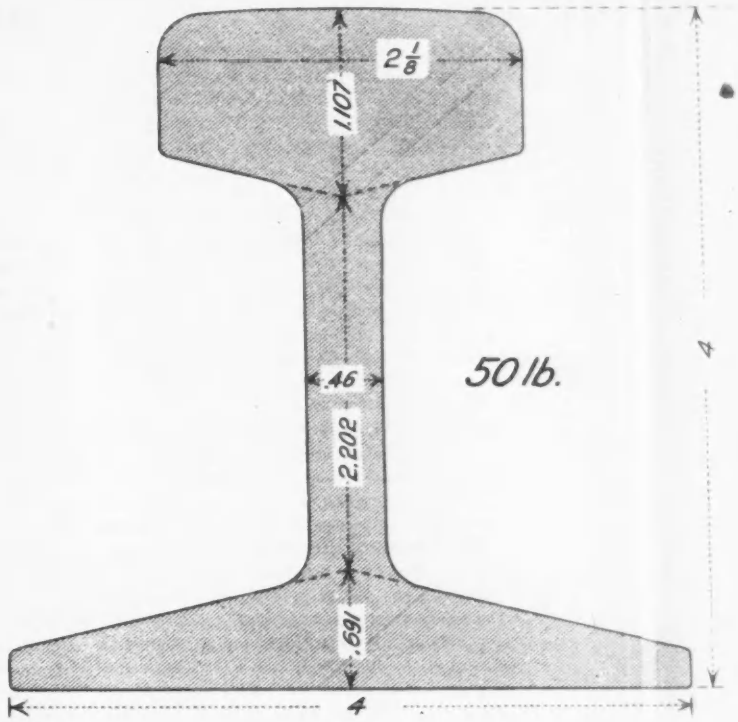
The share of the United States in this output is too small to be worth attention. It is to be hoped that it may soon be larger.

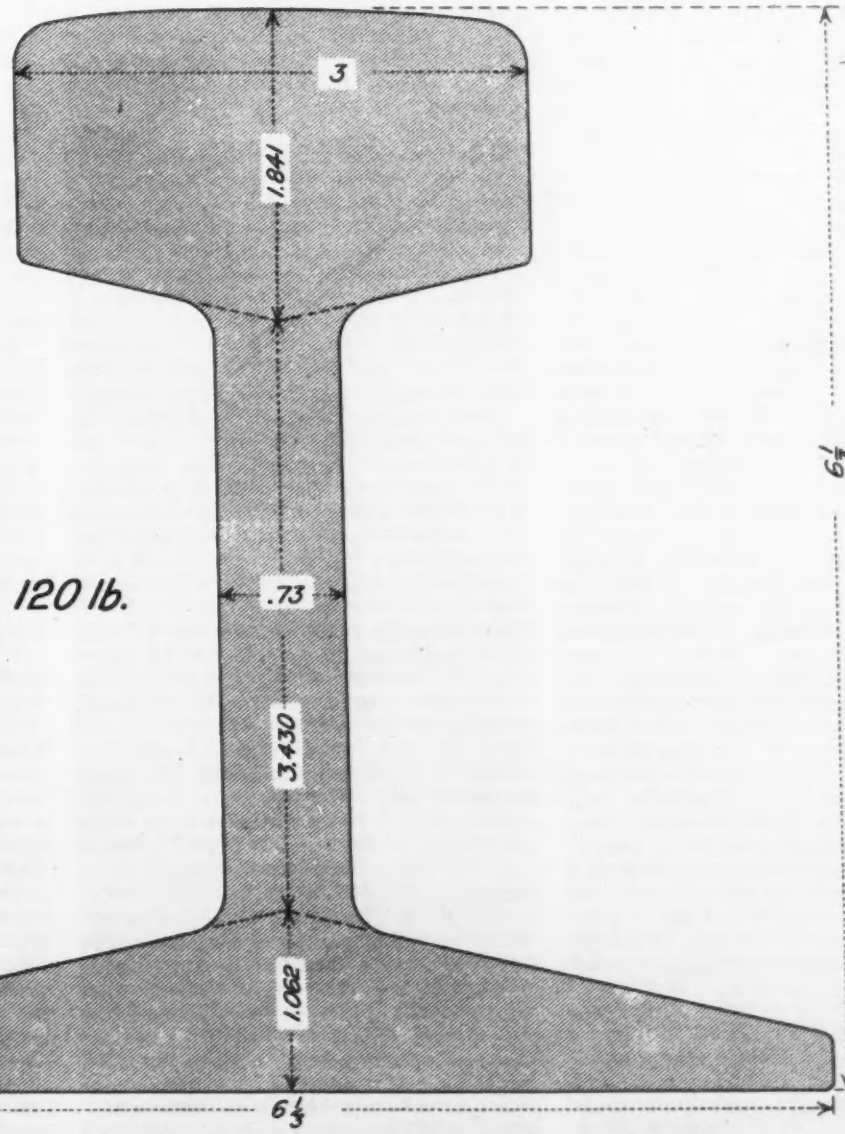
The Stay-Bolt Problem.

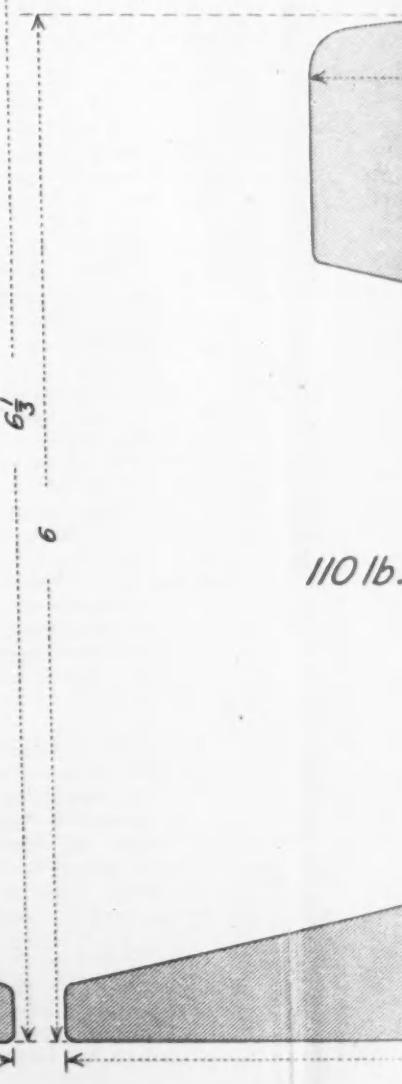
It must be acknowledged by every careful observer that modern steam engineering practice is much farther advanced in the utilization of the steam to produce power than in the generation of the steam in the boiler. In many directions the art of steam boiler design has made rapid progress, but taking average practice there is much more chance for improvement in the boiler than in the engine.

The rapid introduction of multiple expansion engines for all places where considerable amounts of power are used, and the consequent demand for higher steam pressures, are emphasizing the defects of steam boiler design and proving the need of some radical changes to meet future demands. The problem of staying flat surfaces has received most attention in locomotive practice; but it is destined in the future to become of much greater importance in general steam engineering that it has in the past. The reason for this is that, so far as can now be seen, the internally fired boiler promises to increase greatly in importance in the future. Not only is it much more compact and effective in proportion to its size than the externally fired boiler, but it is also more economical of fuel, unless the latter be worked at an extremely slow rate. But there are only two









NOTE.

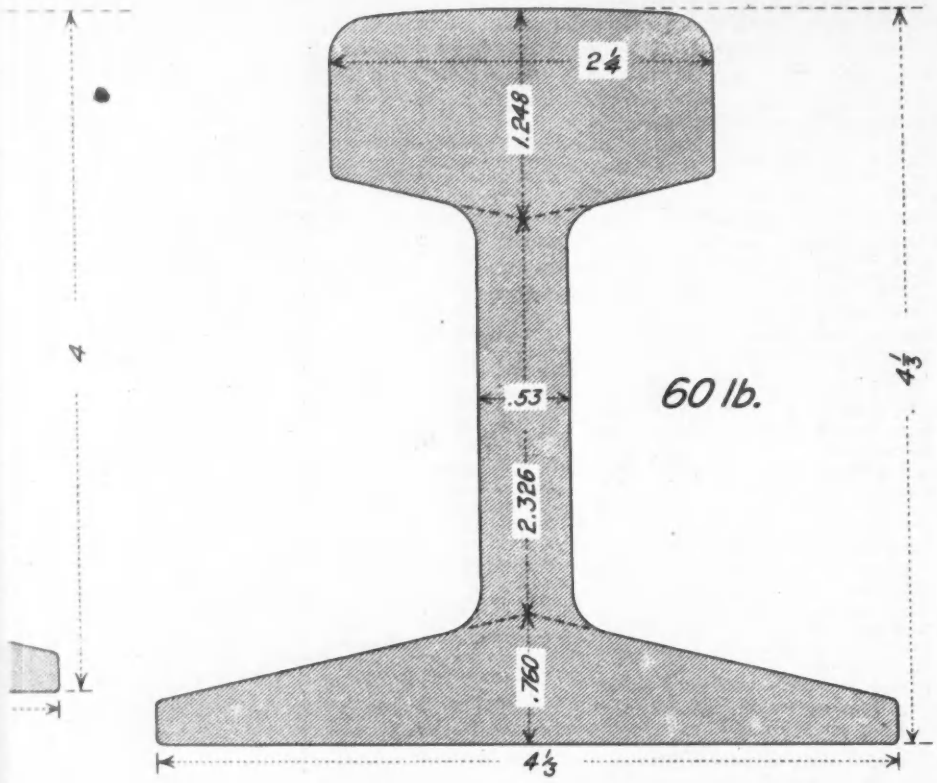
As stated in the report of the Secretary, the wide variations from the average, appearing only in single sets of sections (out of 11 sets submitted), were neglected in determining the averages.

These neglected variations were the following: 1. In Mr. Morison's sections, the constant width of head for sections of all weights. 2. In Messrs. Goodwin and Rea's sections, the $\frac{1}{4}$-in. corner radius, 4-deg. flare in the sides of the heads, semicircular extremities of base and the great percentage of metal in head (46 per cent.). 3. In Mr. Wellington's sections, the constant width of base for sections exceeding 70 lbs. in weight. 4. In Mr. Rodd's sections, the heavy percentage of metal in head (44.6 per cent.). This occurs also in the Goodwin-Rea sections, but in the latter case is due to a general difference in type of section.

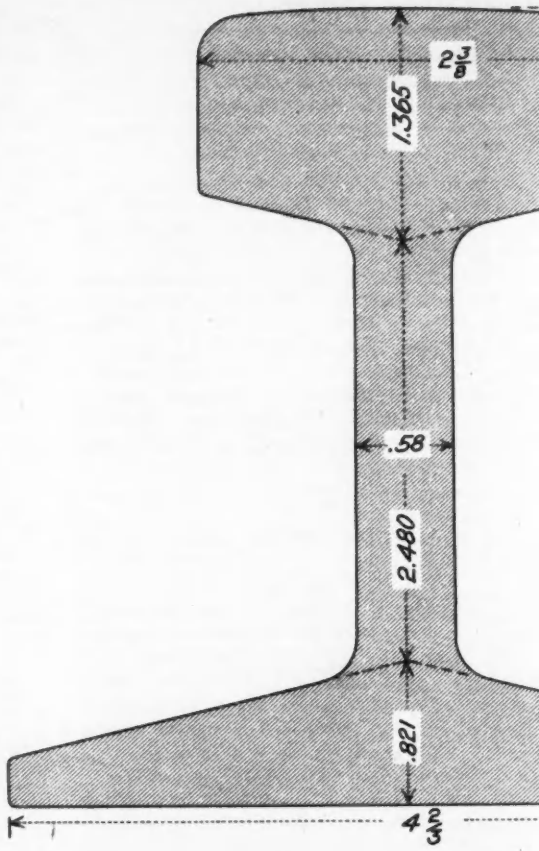
The other variations were too few and unimportant to note except the following: The individual sections were about equally divided between straight and concave (12-in. radius) necks. The sections are drawn with straight necks as the easiest to compute and construct. To construct sides to include the same area with a 12-in. radius narrow the center about $\frac{1}{20}$ (0.05) inch, and widen the extremities of the neck about an equal amount on each side.

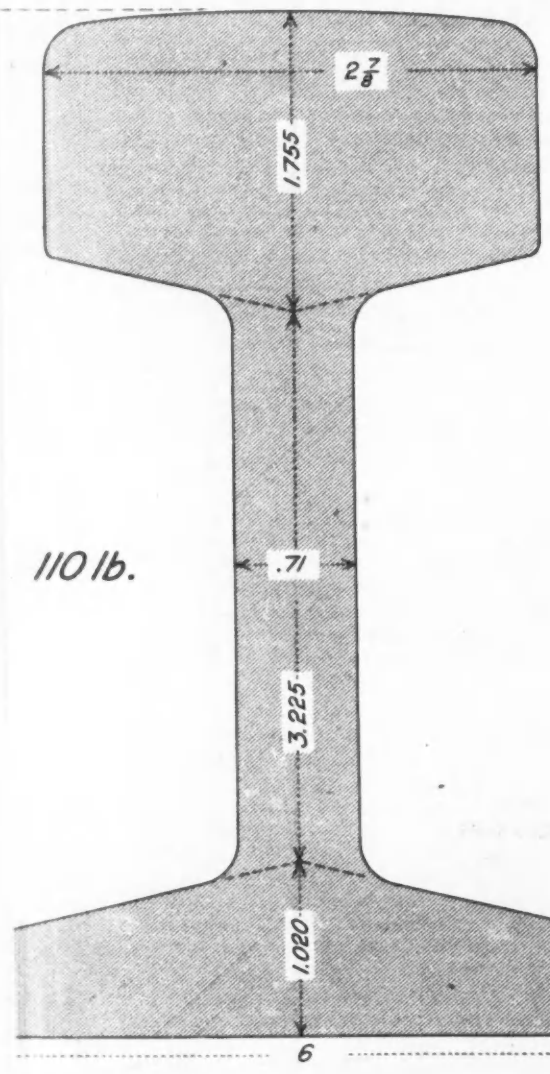
RAIL SECTIONS EMBODYING A MEAN OF THE INDIVIDUAL DESIGNS

CONSTRUCTED IN ACCORDANCE WITH THE MEAN DIMENSIONS GIVEN



60 lb.





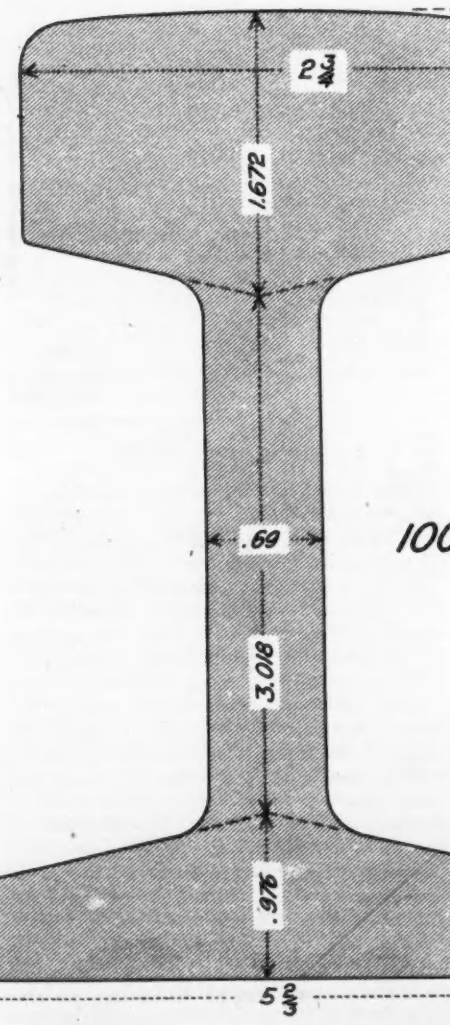
110 lb.

CONSTANT DIMENSIONS COMMON TO ALL THE SECTIONS, AND HENCE NOT SHOWN ON ANY OF THEM.

1. 12.-in. top radius.
2. ¼-in. top corner and fillet radii.
3. 1/16-in. radii for all other corners.
4. 13 deg. angle with horizontal of top of base and under side of head.
5. 41.5 per cent. of metal in head.
6. 21.0 per cent. of metal in neck.
7. 37.5 per cent. of metal in base.
8. Vertical sides.
9. Width of base equal to total height.

UNIFORMLY VARYING DIMENSIONS.

10. Width of head varies 1/16 in. per 5 lbs. per yd. of section ; ⅛ in. per 10 lbs.
11. Width of base varies ⅛ in. per 5 lbs. per yd. of section ; ¼ in. per 10 lbs.
12. Total height varies ⅛ in. per 5 lbs. per yd. of section ; ¼ in. per 10 lbs.
13. Area of section, 4.9 sq. ins. per 5 lbs. per yd. of section ; 9.8 sq. ins. per 10 lbs.



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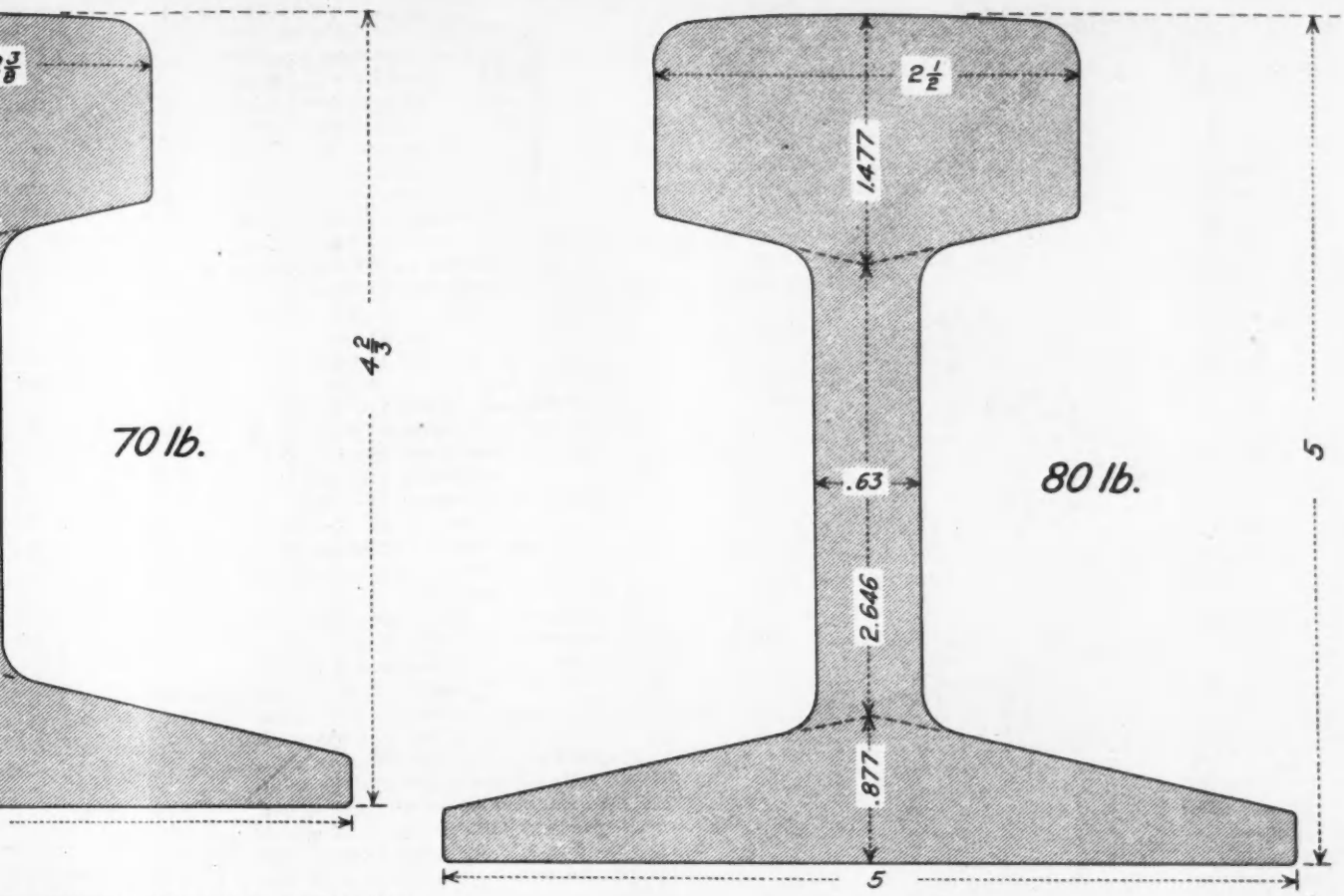
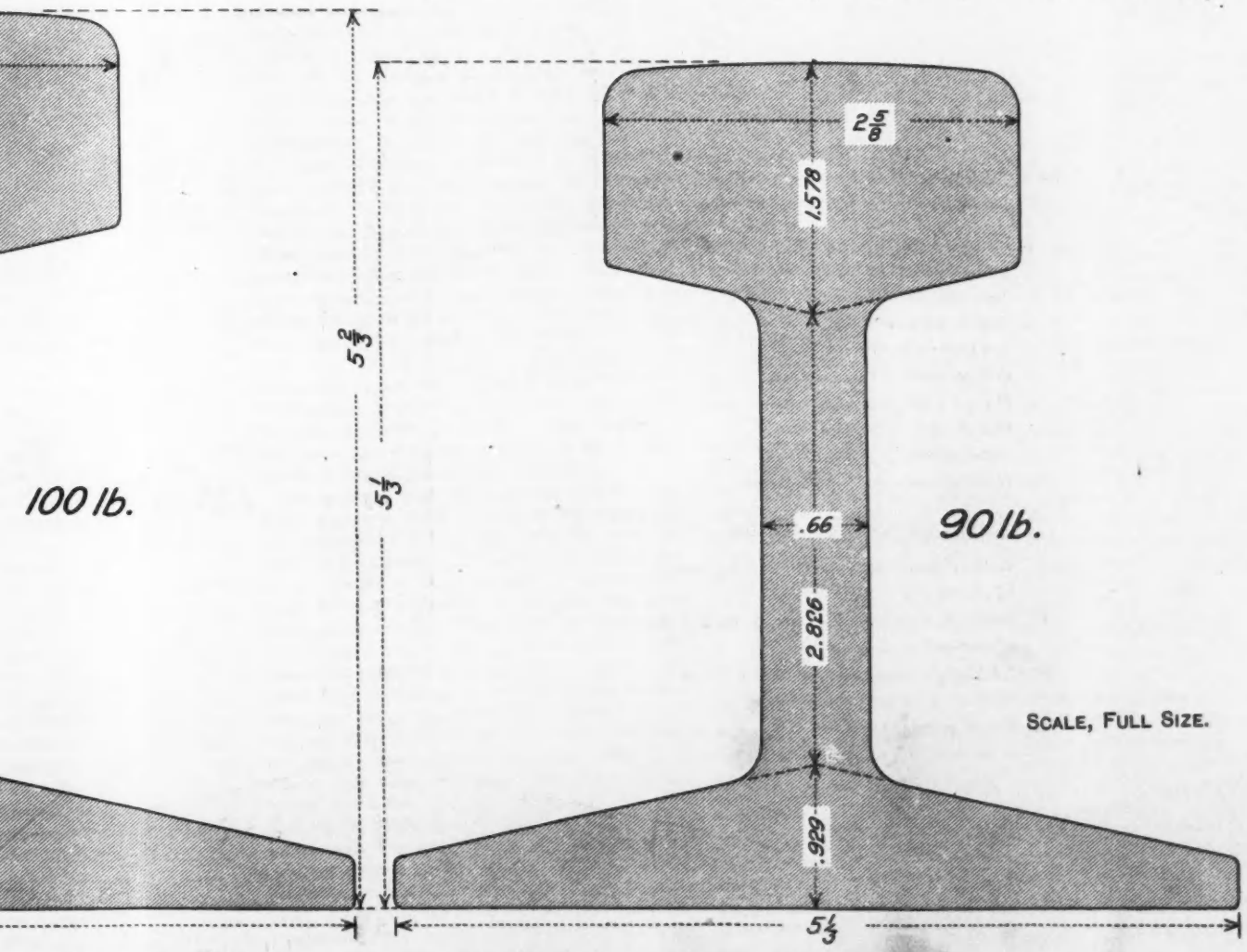
SIGNS FOR STANDARD SECTIONS, SUBMITTED BY THE SEVERAL MEMBERS OF THE AM. S

S GIVEN IN THE REPORT OF THE SECRETARY OF THE COMMITTEE, EXTENDING THE SERIES AS THERE GIVEN TO





SCALE, FULL SIZE.

AM. SOC. C. E. COMMITTEE ON STANDARD RAIL SECTIONS.

EN TO INCLUDE SECTIONS OF 110 AND 120 LBS. PER YARD.

CHAS. HART & SONS, LITH., 26 VESEY ST., N.Y.

types of internally fired boilers (if we except possibilities in the shape of sectional boilers)—viz., the marine boiler and the locomotive boiler.

The marine boiler furnace is circular in cross-section and sustains by its own strength the pressure of the steam tending to collapse it. The ordinary locomotive boiler furnace is composed wholly of flat surfaces, and most of the modern innovations have more or less flat surface. These surfaces can sustain the pressure tending to bulge them inward only by being tied to the opposite wall of the water space, against which the pressure is in the contrary direction.

For moderate pressures the marine boiler has done for many years the best of service; but for very high pressures, especially where forced draft is used, it has developed many and serious faults. In the British navy the use of forced draft has been abandoned, except for cases of emergency, on account of its ruinous effect on the boilers. On the other hand, the universal use of the locomotive boiler, with a forced draft far stronger than any ever used with marine boilers, proves that it is well suited for forced draft and well able to endure the severe strains which that method of working imposes. Moreover, the stayed furnace is not limited in size, as is the tubular furnace; it can be made of any shape to suit its special work and location, and it is, we believe, on the whole, a cheaper method of construction.

The main difficulties in the use of internally fired boilers of the locomotive type are the difficulty of keeping clean the stayed surface, and the gradual deterioration and breaking of the stay-bolts. How serious a matter this is, is probably not realized by engineers not familiar with locomotive practice. The breakage is not caused by the tensile strain due to the steam pressure. A ¾-in. stay-bolt spaced 4 ins. from its neighbors, which may be taken as fair average practice in locomotive construction, has an effective area after the screw thread is cut of about 0.42 sq. in., and sustains a strain of 2,400 lbs. at 150 lbs. steam pressure, equivalent to 5,714 lbs. per sq. in. If a ¼ in. hole is tapped into it, as is done in the best practice, to give warning in case the stay-bolt breaks, the strain sustained is only slightly greater, 5,890 lbs. per sq. in. The ultimate strength of a ¾ in. screwed stay-bolt, riveted over at the ends, as is usual in locomotive practice, was determined by experiments under the direction of a committee of the Master Mechanics' Association to be about 21,000 lbs.; and failure occurred in every case by the bolt pulling through the sheet. From this it seems that a ¾ in. bolt, sustaining a pressure of 150 lbs. per sq. in. against an area of 16 sq. in., has a factor of safety so far as direct tensile strains are concerned of nearly 9.

It is apparent from this that the stay-bolts are amply strong to resist the direct steam pressure, and, as a matter of fact, they never fail from any lack of such strength. What causes their breakage, according to the universally accepted theory, is the unequal expansion of the inner and outer plates of the fire-box, which tends to break them precisely as a wire is broken off when held in the fingers by repeated bending back and forth. The plates are held fast at the bottom by the foundation ring; and as the inner plate becomes heated and expands, it moves up with irresistible force, bending the stay-bolts toward the top at the points where they enter the inner and outer sheets. When the boiler cools, of course, they are bent back again. This bending back and forth, combined with the tensile strain, naturally causes a gradual fatigue of the metal, which is doubtless stretched beyond the limit of elasticity, in many cases, every time the boiler is fired and cooled off. Larger stay-bolts do not remedy the matter, for the stress on the outside fibres from a given bending force increases with the diameter of the bolt. Closer spacing is a better remedy, but does not touch the root of the matter (the bending strains) and there are limits to it, for when the bolts are put much closer together than in present practice the stiffness of the plates tends to cause unequal distribution of the stress. Widening the water space near the top decreases the bending of the stay-bolt for a given movement of the plates. In locomotive practice, however, it is difficult to do this.

Since breakage of stay-bolts is caused by fatigue of the metal, the very best test for stay-bolt iron is to place a piece in a vise and bend it back and forth, noting the number of times it will endure bending through a given angle before rupture occurs.

The test is usually applied by fixing a piece of the iron 2½ to 3 ft. long horizontally in a vise, slipping over it a loosely fitting piece of pipe to serve as a lever, the end of the pipe being 6 ins. from the jaws of the vise. The iron is bent to a right angle, then straightened, then bent to a right angle in the opposite direction, and so on. Good stay-bolt iron should stand at least 12 right angle bends in this way without breaking. What is sold in the market as good stay-bolt iron will endure from 4 to 16 such bends.

These tests have shown that the ordinary tensile or torsional tests cannot be relied on to indicate the ability of the metal to endure alternating strains. A peculiar feature which we have witnessed in these tests is the effect of strains beyond the elastic limit to harden the metal and increase its actual strength while decreasing its resilience. Each bending requires a greater force than the preceding. This test for stay-bolt iron was first adopted by Mr. F. M. WILDER, on the New York, Lake Erie & Western; and it is now in use, we believe, on a number of prominent railways.

Breaking of the stay-bolts is not the only evil due to the unequal expansion of the inner and outer sheets. If the sheet is thin, the bolt sometimes works loose by the constant bending, causing leakage, or even pulling through the sheet if the latter be overheated. Cracking of the side sheets, and grooving and corrosion of the sheets about the junction of the barrel of the boiler with the firebox and above the foundation ring, are among other evils generally ascribed to the same cause.

It was at one time proposed to remedy these various evils by putting a few corrugations in the side sheets. These gave the plate a chance to "breathe" when it expanded without bending the staybolts so severely. The corrugations caused more injury and tendency to split from the effect of unequal heating, however, than they did good by facilitating expansion and contraction, and now we believe plain sheets are all but universal.

At the last meeting of the New England Railroad Club the subject of stay-bolting was discussed, as reported in another column; but corrugation of the side plates was not mentioned. The only remedy suggested for the troubles complained of was the use of large bolts with careful inspection and frequent renewals. The most important and progressive railways of the country, so far as we can learn, have not found any more satisfactory means of obviating the trouble. At a recent visit to a certain railway shop generally regarded as a model for progressiveness, some stay-bolts were seen with a sort of ball-and-socket joint, for use in the upper corners of the fire-box. It was an expensive and complicated arrangement, as the mechanical engineer in charge acknowledged, and one only experimented with because of the serious troubles experienced with ordinary bolts.

In view of these facts and of the possibilities in the use of the locomotive type boiler for marine and stationary work, it seems well to inquire whether some more radical reform is not needed for the solution of the stay-bolt problem. Taking it as proved that the root of the trouble lies in the unequal expansion of the fire-box plates, it follows that if means can be provided to obviate this unequal expansion the problem will be solved.

The first and easiest step in this direction is to increase the heat of the outside plate of the fire-box. The difficulties in lagging the exposed surface of locomotive fire-boxes are admitted; but even a thin coat of lagging would greatly check loss of heat by radiation and ought to be applied anyway on economical grounds. Some actual tests on the Lake Shore road, which we have several times before referred to, showed an economy of no less than 10 per cent. from such lagging, in fuel alone. On marine and stationary boilers no difficulties whatever exist with regard to lagging but generally a much better method of increasing the heat of the outside plates can be adopted. The waste gases of combustion can be led around the exterior of the fire-box before passing up the chimney and it can thus be warmed somewhat above the temperature of the water in the boiler.

But of much more importance than warming the outer plate is cooling the inner one, or rather ensuring the rapid transfer of the furnace heat to the water in the boiler. What are the average temperatures of the outer and inner plates on the sides of a locomotive fire-box, we have no means of knowing. But it is certain that the inner plate, exposed to the direct heat of the furnace at a temperature of perhaps 2,000° Fahr. or higher, must be much hotter than the water in the boiler. Further, it is altogether likely that in a hard-worked locomotive boiler the seething mass in the narrow water space around the fire-box absorbs heat from the inner plate much more slowly than would a mass of solid water. In some recent foreign experiments a pipe was placed with its opening close to the tube plate of a hard worked forced-draft furnace and led outside the boiler. On opening the cock in the pipe it was found that no solid water could be drawn from it. Practically the same experiments, with the exception that the pipe opened within about ¼ in. of the furnace sheet, were made a few years ago on the Lake Shore & Michigan Southern Ry., and with the same results.

Experiment thus clearly proves the exceeding violence of ebullition in the water space around the furnace. A little calculation of the rate at which steam is disengaged shows the state of affairs even more clearly. The rate of evaporation per hour per sq. ft. of the heating surface in the fire-box of a locomotive may be as high as 120 lbs., or 2 lbs. per minute. The volume of one pound of steam at 125 lbs. pressure is 3.16 cu. ft.; hence the total volume of steam generated per sq. ft. of fire-box heating surface per minute at this rate of evaporation is 6.32 cu. ft. Taking the depth of the water leg as 5 ft. 6 ins., and its width as 4 ins., we have a total amount of 34 76 cu. ft. of steam rising each minute from each lineal foot of the water space. The sectional area of the water space is ⅓ sq. ft. per lineal ft. Hence, if we assume that all the water space is occupied by the ascending steam, we have the astonishing velocity of over 100 ft. per minute for the steam rising from the space around the furnace.

Remembering that water must flow down in the opposite direction to the ascending steam to take the place of the water evaporated and entrained in the steam, and that this rapid flow and generation of the steam goes on through the water contained in the leg, it becomes apparent that the water in the space about the fire-box must be a mass of seething foam, whose cooling effect on the furnace sheet must be much less than that of the same bulk of solid water. What is needed is to facilitate the entry of the water and the exit of the steam from this narrow space, and the obvious mode of doing this is to separate the ascending current of steam and water from the descending current of water.

This might perhaps be done by simply placing in the water space a flat plate of sheet iron, perforated to admit the passage of the stay-bolts, thus partitioning the space into two unequal compartments, the narrower on the outer side for the down-

flowing water, the wider on the side next the furnace for the rising current of mixed steam and water. Experiments have shown that the evaporation from a surface is many times greater when the water is flowing over it than when it merely stands upon it. The velocity of the current breaks away the steam bubbles as they form, and keeps water in contact with the heated plate. It is possible then that the provision of circulating plates around a firebox would considerably decrease the temperature of the furnace plates. It is also possible that if not of exactly the right proportions they would have a contrary and evil effect, but at least here is a direction for experiment. There are other advantages which might be gained by the use of circulating plates. The evaporative power of the boiler, as well as the evaporation per pound of fuel, might be largely increased, partly because of the more rapid transfer of heat, but principally because the rapid circulation would greatly reduce the formation of scale on the side sheets. The loss in effectiveness due to a coating of scale is said by Babcock & Wilcox to be 13 per cent. for scale only $\frac{1}{16}$ in. thick; and it need hardly be said that as the transmission of heat to the water is obstructed, the temperature of the plate increases.

The most probable difficulties with such an arrangement of circulating plates are a liability to foaming and perhaps a more rapid tendency to a rapid deposit of sediment around the foundation ring. The first of these might perhaps be provided against by a suitable arrangement of baffle plates, and the sediment if it gave trouble might be taken care of by the excellent device designed by Mr. BARNES, of the Wabash Ry., and described in our issue of Aug. 9, 1890. As already stated, a chief objection to the use of the locomotive type of boiler in marine service has been the collection of scale on the stayed surfaces. If this scaling can be avoided by the use of circulating plates it will go a long way toward popularizing the stayed type of boiler in marine service.

It is to be remembered also by those engaged in general steam engineering that some special difficulties in locomotive service which make the stay-bolt problem peculiarly serious there can easily be avoided in applying the locomotive type of boiler to other service. The bending action on the stay-bolts is reduced as the width of the water space is increased, and in designing a locomotive boiler for stationary or marine service the width of the water space should always be increased at the top, where the bending action on the stay-bolts is concentrated. By doing this, and leading part or all of the waste gases around the outside of the fire box, trouble with stay-bolts would probably disappear, as already noted.

A word may also be said in this connection as to the use of forced draft in stationary and marine practice. It is pretty well understood that forced draft can only be an economic success with an internally fired boiler; and it has already been shown that, so far as present experience indicates, the locomotive type alone is suited to forced draft. Anything which tends to remove the present defects of the locomotive boiler, therefore, makes possible the use of forced draft in places where it has not heretofore been successful.

A Mean Set of Rail Sections.

In our issue of Feb. 21, 1891, we gave on a large inset sheet ten different sets of designs for a series of standard rail sections, prepared independently, and without any prior discussion in committee, by as many different members (or rather by 11 different members, since two members submitted a set in common) of the Am. Soc. C. E. Committee on Standard Rail Sections, so that each set represented purely individual opinion of what such a set of sections should be. As will be seen by referring to the sheet in question, 9 of the 10 series of designs showed a remarkable degree of agreement with each other, and even the tenth had many points of agreement with the rest.

In the same issue we published the report of the secretary of the committee, summarizing, in pursuance of a resolution of the committee, the points in which these several sections agreed and disagreed. At the close of this report he added the following:

> At an informal meeting of the committee, held after the annual meeting, it was recommended that the Secretary prepare a set of sections averaging as nearly as might be the individual sections, neglecting any wide deviations which appear in one set of sections only. The Secretary's engagements have not permitted him to do this, but a set having the following dimensions would come very near to such an average section:
>
> *Head*, 12 ins. radius; top corner, ¼ in.; lower corner, $\frac{1}{16}$ in.; vertical sides; percentage of metal, 41.5% (neglecting both the GOODWIN-REA and RODD sections as erratic); width varying by ⅛ in. for each 10 lbs. per yd., and as follows:
>
> | Weight of section in lbs... | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
> |---|---|---|---|---|---|---|---|
> | Width of head in ins..... | 2.0 | 2⅛ | 2¼ | 2⅜ | 2½ | 2⅝ | 2¾ |
>
> *Neck*, 21% of the metal; ¼-in. top and bottom fillet radii; either straight sides or 12-in. side radius (there appears to be a division of sentiment on this point); thickness as determined by percentage and following dimensions:
>
> *Base*, 37.5 % of the metal; 13° top angle (as also for under side of head); width same as total height of rail; vertical sides with $\frac{1}{16}$-in. top and bottom corner radii.
>
> *Total height and width of base* varying by ⅛ in. for each 10 lbs. of section, and as follows:
>
> | Weight of section in lbs.. | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
> |---|---|---|---|---|---|---|---|
> | Total height and width, ins..... | 3.67 | 4.0 | 4.33 | 4.67 | 5.0 | 5.33 | 5.67 |
> | Actual average for do .. | 3.88 | 3.98 | 4.28 | 4.66 | 4.98 | 5.32 | 5.67 |

We have thought that it would be of interest to our readers, and perhaps of use to the committee, to prepare a "mean" set of sections drawn in accordance with the average dimensions thus stated, which we have done on the accompanying inset sheet. By comparing this sheet with the former one it will be seen how surprisingly little difference in general appearance there is between these "mean" sections, and at least 8 out of the 10 sets of individual designs submitted. The two partial exceptions are Mr. MORISON'S and Messrs. GOODWIN and REA'S designs, but the first differs only in the one peculiarity of maintaining a constant width of head (2¼ ins.) for all weights of sections, and the second, while in some respects a decided exception to the rest, differs from them much less than prior designs of its general type have done.

We have also varied from the series as specified in the above quotation by extending it to include 110-lb. and 120-lb. sections, constructed under the same general rules, in order that it may be apparent what such sections would look like when thus constructed. As there are already in use on this continent 110-lb. rails (on the Chignecto Ship Railway), and as there are a number of different sections in use in Europe for general railway service of nearly or quite that weight, it is obvious that 110-lb. rails at least may soon cease to be a rarity, and that 120-lb. rails may come soon, so that it is desirable to cover such weights in any sections which may be recommended.

Under its resolution of appointment, as it now stands, the committee is to recommend standards "varying by 5 lbs. yer yd. from 40 to 100 lbs. inclusive." So far as filling in the 5-lb. sections, that is a mere detail, after the even 10-lb. sections have once been agreed on. It is unnecessary to even consider the 5-lb. intermediates until that stage of progress has been reached. But to extend the series above 100 lbs. per yd. is a different matter. The committee will hardly feel authorized to do this without express authority, and it might be well that it should apply for this authority at the coming convention, as also, perhaps, for authority to see what could be done in the way of agreement on a standard spacing and form of bolt holes, without agreement on which standard sections would lose much of their utility.

The accompanying sections have at least the merit of extreme simplicity of construction. Almost every dimension is either constant throughout all the sections, or uniformly variable from section to section. The only dimensions which are in a measure arbitrary are (1) the extreme center height of the head and (2) of the base, with (3) the residuum of the total height, which makes the height of the neck and (4) the thickness of the neck. Even these four dimensions vary by a uniform law, but not quite in uniform ratio. For example, the thickness of the neck varies by 0.07 ins. for each 10 lbs. per yd. of section on the light sections, which falls to only 0.02 ins. on the heavier sections, and above 120 lbs. per yd. (if such sections were ever likely to be required) it would soon cease to increase at all, or even diminish. This results from the fact that one of the constants is 21 per cent. of the total metal in the neck, and another ½-in. increase of total depth for each 10 lbs. per yd. increase of section. Whenever the section is such that an increase of 10 lbs. per yd. and ½-in. in height adds just 21 per cent. to the height of the neck, the thickness of the neck will not increase. In this dimension, therefore, as in the other three just mentioned, there is no arithmetical or other simple law of progression. It must be determined by computation or construction from the other given constants.

As listed on the face of the inset sheet, the constant dimensions are:

Constant dimensions common to all the sections, and hence not shown on any of them.

1. 12.-in. top radius.
2. ¼-in. top corner and fillet radii.
3. $\frac{1}{16}$-in. radii for all other corners.
4. 13° angle with horizontal of top of base and under side of head.
5. 41.5 per cent. of the metal in the head.
6. 21.0 " " " " " " " neck.
7. 37.5 " " " " " " " base.
8. Vertical sides.
9. Width of base equal to total height.

Uniformly varying dimensions.

10. Width of head varies $\frac{1}{16}$ in. per 5 lbs. per yd. of section; ⅛ in. per 10 lbs.
11. Width of base varies ⅛ in. per 5 lbs. per yd. of section; ⅛ in. per 10 lbs.
12. Total height varies ⅛ in. per 5 lbs. per yd. of section; ⅛ in. per 10 lbs.
13. Area of section, 4.9 sq. ins. per 5 lbs. per yd. of section; 9.8 sq. ins. per 10 lbs.

Briefly summarizing the exceptions which occurred in the original individual designs, they were as follows:

1. *12-in. top radius.* No exceptions. The 10 sections were unanimous on this detail.

2. *¼-in. top corner radius and fillet radii.* 9 sections agree on this for top corner, 1 (Goodwin-Rea) having ½ in. For fillet radii, 7 agree on ¼ in., 1 (Myers) has $\frac{5}{16}$. 1 (Morison) adopts a varying fillet radius averaging about ¼ in., 1 (Crowell) adopts $\frac{1}{16}$ for the top, and ⅛ to $\frac{1}{16}$ bottom fillet radius. No one proposes the larger radii of ⅜ to even ½ in. which have sometimes been employed.

3. *$\frac{1}{16}$ in. radii for all other corners.* There were a few trifling exceptions each way from this on some one of the 6 corners per section involved, ranging from a sharp corner as one extreme to ¼ in. as the other, but these minor exceptions were comparatively few, and about equal in number each way, and the only decided exception was the semi-circular end ($\frac{3}{64}$ in. radius) to the base of the Goodwin-Rea sections.

4. 13° *angle of top of base and under side of head.* 4 sets of sections only had this angle, but the average of the remaining 6 was precisely 13°, the range being from 11° to 14°02'.

5-6-7. 41.5 *per cent. of metal in the head*, 21 *per cent. in the neck*, 37.5 *per cent. in the base.* The closeness of agreement as to this can be best seen from the tables published with the secretary's report in our issue of Feb. 21. The precise average indicated slightly more metal in the head, but these were taken as suitable even figures (they are)

the same as those assumed by Mr. GEO. S. MORISON, after excluding as exceptional aberrations in this item the Goodwin-Rea average (46.1 per cent.) and the Rodd average (44.6 per cent). The remaining 8 sets ranged only between 40 and 43.2, averaging 41.9 per cent.

8. *Vertical sides.* 9 of the 10 sections agree in this. The Goodwin-Rea sections have a slight (4°) flare. 9 of the 10 sections have also vertical sides to the base, with small corner radii at top and bottom.

9. *Width of base equal to total height.* The only exceptions in this respect were that the Goodwin-Rea set had the height $\frac{1}{4}$ in. less than the base throughout, and that, on the other hand, two sets narrowed their larger sections slightly with a view to the use of base plates. For 80-lb. sections or less 9 of the 10 sets agreed on this.

As to the uniformly varying dimensions, the individuals sets were divided as follows:

10. *Width of head increasing $\frac{1}{8}$ in. per 10 lbs. per yd.* Only two sets (FELTON, WELLINGTON) showed this precisely. The others varied more or less irregularly, the total range from 40 to 100 lbs. per yd., averaging 0.79 ins., or 0.131 per 10 lbs. instead of the 0.75, or 0.125 per 10 lbs. assumed. Mr. MORISON's absolutely uniform width decreased this average range, which would otherwise have been 0.85 ins. in all, or 0.142 per 10 lbs. per yd. But the general aim seemed to be to increase a little more than $\frac{1}{8}$ in. per 10 lbs. per yd., and but one set averaged as much as 15 per cent. more than this.

11-12. *Width of base equal to total height, and varying by $\frac{1}{4}$ in. per 10 lbs. per yd.* How nearly all the sections agreed with this law is shown in part by the quotation above. Only one set followed it precisely, but this appears to have arisen chiefly from an unwillingness to use thirds for fractional dimensions. Thus the rule, as stated, calls for just 2 ins. difference in height between 40-lb. and 100-lb. sections. The actual differences were:

1¾ in.	1⅞ in.	2 in.	2⅛ in.	2¼ in.	2⅜ in.
5	1	2	1	3	1

With this summary we leave the "mean" sections shown herewith to the consideration of our readers. What the next step of the committee will be has not yet been determined. It appears probable from the sections that they could without great trouble reach a unanimous agreement among themselves on some one set of sections, but it seems hardly probable that they will even attempt to do this until they have consulted by circular both the rolling mills and railways. It might prove of little avail to recommend a series of standard sections unless it was agreed by the rolling mills, on the one hand, to furnish these sections to any customer without charge for rolls, and unless it was known, on the other hand, that a majority of the railways at least were prepared to use the sections if recommended. Judging from the experience of the former committee it ought to be possible to obtain agreements of this nature from all the rolling mills and 80 or 90 per cent. of the railway mileage. The future alone can tell whether this can be and will be done. In any event, much has been already accomplished by the clear indication which has been given of the present "stream of tendency" as to rail sections.

CORRESPONDENCE.

A New Type of Hinged Arch—Explanatory.

DETROIT, Mich., March 16, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

DEAR SIR—In your illustration published March 14, showing the general outline for a three-hinge arch to be erected on the cantilever principle you have made a serious omission. Referring to the original sketch sent to you, it is stated very clearly that the joints *A* are connected during the process of erection by links, which are removed after the coupling is made at center pin.

If this explanation had been made, it would have illustrated my design in its proper light. That is to say, it would have made clear the fact that, after the coupling is made at the center pin, and the joints *A* are disconnected, the two shore arms are disconnected spans, while the two river arms form an independent three-hinge arch. It is clear, after this is explained, that my design has nothing in common with the design proposed for the Viaur Viaduct in France. The plan as proposed is a special design for a special crossing, and combines the advantages of the arch with the cantilever, without having the mechanical difficulties of either of them.

J. W. SCHAUB.

[We regret that this important omission occurred, but our correspondent sent his own letter, giving his own description of this design; and a moment's reflection will show him that he is chiefly responsible, and not we, for any essential omission from that letter. In articles prepared in this office, we are alone responsible for omitted facts which we might have obtained from any source, but a correspondent's letter is not ours to doctor. It is supposed to contain what he wishes to say and all he wishes to say. We rarely add to or substract from it, since we do not hold ourselves responsible for it. Our part in regard to it is a merely formal one. The accompanying drawings are turned over to the engraver, and all that is *a part of the drawing* is engraved, but written text in a corner of the blue print, not a part of the drawing, is supposed by the engraver to be included in the accompanying communication. We frequently do detect important omissions of the nature complained of, and add whole sentences to letters sent for publication when it is clear that the omission was accidental, but we are in no way bound to say so, since it is not we, but the writer, who is addressing the public. It is enough for us to be responsible for matter which we prepare ourselves for public information.—ED. ENG. NEWS.]

A Suggestion as to Signal Lights.

OCONTO, Wis., March 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

DEAR SIR: I have read with much interest your article on the Fourth Ave. tunnel disaster, in your issue of March 7, in which you suggest that the cause of that accident was that a white light seen through smoke looks red, and so that an actual red light seen through smoke may easily be mistaken for a white light in a hasty glimpse. I would like to make a suggestion with regard to signal lights: Why not, instead of a white and a red light, use a white light *and no light?* If my idea is worth anything, there is plenty of chance to elaborate on it; if not, it will take but few words to demolish it.

EDWIN R. PARKS.

[The sole objection to this course, which is a very serious one, is that the danger signal becomes purely negative, and a man has only to forget that he ought to see a white light there to run right by it. In all good signaling practice *no light*, where there ought to be a light displayed, is already a danger signal, and is required by regulations to be treated as such; but no great reliance is placed on it.—ED. ENG. NEWS.]

A Brooklyn Bridge Terminal Plan.

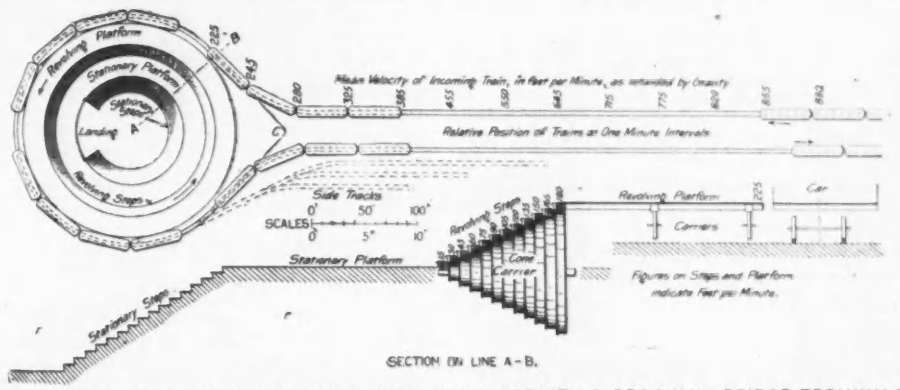
KANSAS CITY, Mo., March 10, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: To comply with your intimation that more details were needed as to my proposed movable platform, I have made the accompanying diagram. In the discussion of plans for increasing the capacity of the Brooklyn Bridge, the advantages of a loop track at the terminals are now pretty well understood. The object of the device here shown is to increase this advantage by causing the landing platform to move with the train. The accompanying diagram is not given as indicating the only or best mode of operation, but to enable a concise analysis of the required movements to be made.

The incoming train is retarded by an incline, so that when it reaches the platform it will have about its motion (225 ft. per minute). A short tangent in the track enables the grip to take the auxiliary cable (indicated at *C*), which being driven by the same machinery as the platform, insures corresponding motion. This platform, being 200 ft. or more in diameter, may and should move as steadily and as smoothly as a steamer approaching a dock, and as the movement of the train while attached is exactly with it, exit and entrance are practically the same as if both were at rest.

As the movements of incoming trains are alike in like localities, it is only necessary that a train attached to the platform should move slightly more than its own length during the interval between successive arrivals. In the diagram this interval is given as one minute, and the cars remain connected with the platform over two minutes.



PLAN AND SECTION SHOWING PROPOSED METHOD OF OPERATING BROOKLYN BRIDGE TERMINALS.

The revolving platform is connected with a stationary platform or landing by a flight of steps, which revolve with the platform, but with successively less motion, the lower one being almost still. The movement of the platform is that of a slow walk (2.5 miles per hour), and the change of place between any step and the next, during the time occupied in making a step, is but from 2 to 3 ins. The platform and trains can be started or stopped, together or separately, almost instantly. The irregularity of travel will only require the movement of the platform a few hours per day; while at rest it is the landing required by the loop system. Spare trains can at such times be side tracked by gravity, as indicated by the dotted side tracks, and returned to the main track as required, in the same manner.

G. W. PEARSONS.

[Our correspondent's design is one of the most ingenious we have seen for this type of plan, especially in the mechanism for propelling the rings of steps at differential speeds; but apart from any other difficulties or objections, it provides for but a limited capacity, viz., 225 cars per hour, or only 40½% in excess of the present capacity of 160 cars per hour. The ultimate limit of the plan, a continuous stream of cars moving at 2½ miles per hour, is only one-sixth more than this, or 270 cars per hour, a gain of only 68½%. But 16-car trains running on headways of 93 seconds (40 seconds clear headway between trains) and coming to a dead stop to load and unload afford a capacity of 648 cars per hour or 3.86 times the present capacity; while 20-car trains running on the same clear headway afford a capacity of 676 cars per hour, or 4.23 times the present capacity; while a station of the horseshoe form to accommodate such trains extends no further east from Park Row than does a switching terminal proposed to accommodate 4-car trains. It is for these reasons that the type suggested by our correspondent does not seem to offer adequate possibilities to make it worth detailed study.—ED. ENG. NEWS.]

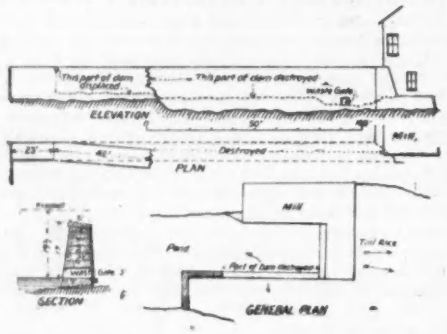
Failure of a Dam.

PORTLAND, Me., Feb. 27, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: A dam of roughly coursed large granite rubble of the dimensions in the inclosed diagram, built during last December, tipped into the river with water flowing over top only 6 ins. deep. The freshet height to be anticipated is 2½ ft. over the top of the dam. The failure occurred without the slightest warning, and the first place to rupture was in close proximity to the waste gate; 63 ft. of the dam remains standing in perfect form, except that 45 ft. of it, which was constructed in October, was swung out of line 2 ft. 6 ins., with no apparent rupture except at the pivotal point.

This last feature surprised me somewhat, because strength of bond in construction is apparently indicated, and to the lack of it, and not errors in dimensions and design may be attributed the cause of the disaster. How-



ever, I do not think that the wall could be called strongly bonded, though it was probably not much less so than ordinary rubble walls. It was laid in courses about 2 ft. in height, and the inner bonding rock, and all rock used as levelers, pinners or filling (which was done in a compact manner) was not laid in full mortar beds, but each course was grouted full with grout made of 1 part Newark cement and 2 parts sand. The wall will probably weigh 140 lbs. per cu. ft.

The method of filling the voids of each course in succession with grout was a part of the specifications. It had seemed to me from the first, and it has been my experience, that such grout is but a very small element of strength to a wall, because it is very likely to separate and leave sand with very small proportions of cement in its voids, and such was the result in this case. A great deal of the grout after four months' time can be crushed in one's hand. The method serves, in most cases, to make a fairly tight wall, much tighter in fact than some walls laid in full mortar joints, but which possess at least the full strength that belongs to a 2 to 1 mortar.

The method that requires a wall to be grouted in courses, rather than to have full mortar joints, makes a constant motive for the contractor to build in a form that is most conducive to successful grout running and it is quite likely, although a presumedly competent inspector was present all the time, that the wall in question, for that reason, had an inferior bond if not other faults. I wish yourself or some one of your experienced readers would comment upon this wall and the probable elements that contributed to its failure.

In an accompanying personal letter, which we have permission to publish, our correspondent says:

The failure of a dam carries with it such significant lessons that I send you an account of one that has recently taken place, unfortunately in my own practice. Of course I do not care to sign my name to it, out of consideration for others as well as myself. Whether one is right or wrong in such matters a burden is almost always imposed. I had criticised very plainly the dimensions of the dam, and objected seriously to the grouting system.

I deferred to at least supposed greater experience, and consented to carry out the plans furnished by the corporation's consulting engineer. The question most pertinent to me is, Was I right in my first criticism of the stability of the dam and the method of grouting? Because if I was wrong, then the failure must have been solely due to lack of bond. I tried for a much better bond than I got, and it is that very practical difficulty that has always led me, in building rubble walls, to have them of apparently surplus strength and laid in full mortar joints.

[The difficulty would appear to have lain in the grouting. The late WM. J. MCALPINE was a strong opponent of grouting, for the very reason named by our correspondent, that the sand and cement speedily separate, as he demonstrated by a test which resulted in excluding it from the Brooklyn dry-dock.—ED. ENG. NEWS.]

A Question of Salary Computation.

CITY OF MEXICO, March 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: A dispute has arisen, the parties to which have decided to abide by what might be your decision in the matter: A party contracts to work at a certain rate per month, and works, say, two months and a fractional part of a month. In settling the same, the question arises, How shall the wages for the fractional part of the month be determined? That is, A claims that the wages or salary for the fractional part of the month should be based on an average of 30 days to the month. B claims that the same should be calculated on the basis of the actual number of days in the month in which the fractional part comes. Which would win should a case similar to the above be carried to court?

EDWIN GAWLER.

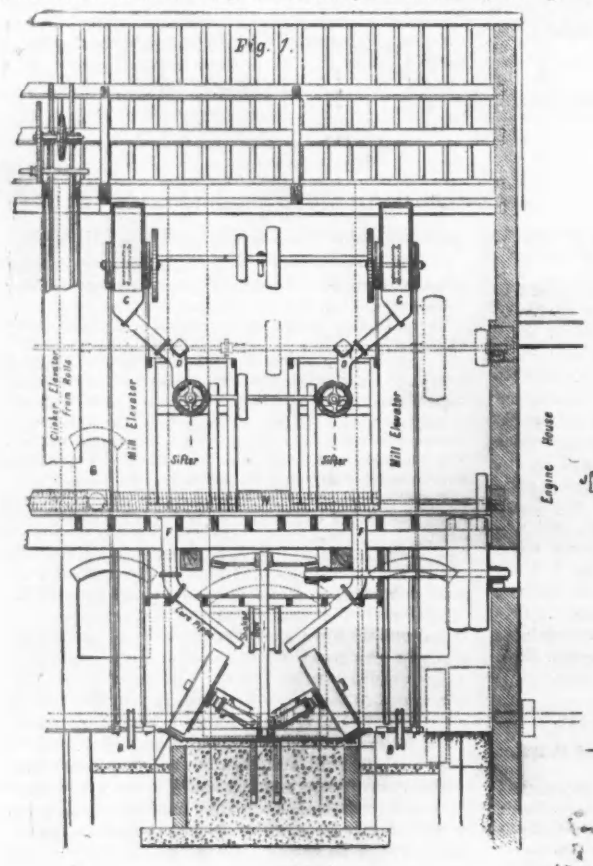
[We doubt if a computation made on either basis could be upset in court. The general custom is to figure 30 days per month except in February, and in that case to figure 28 days; that is to say, the employee is given the benefit of the two short days of February, but is not mulcted of the trifling difference due to the single extra days of some other months.—ED. ENG. NEWS.]

A Novel English Portland Cement Plant.

We find in a recent number of *Engineering* a description and illustrations of a new plant for the manufacture of Portland cement, recently erected at Rochester, England, by Mr. PERCY J. NEATE. The plant is noteworthy because of its departure from usual practice in many important features, especially in the substitution of large iron grinding mills of enormous capacity for the burstones usually employed for grinding the clinker, a change which has often been attempted, but has generally proved a failure. It will be interesting to know whether the new mill stands the test of service well. It should be said that the mill is entirely covered with an iron casing when in use, to prevent the escape of dust. The cogged crushing rolls shown in Fig. 3 do not look especially well adapted to stand severe and steady service without frequent repairs. If they do prove efficient and durable, we shall be glad to know it. In an early issue we hope to give our readers particulars of the very different methods pursued in America in the manufacture of Portland cement.

The plant and its operation is described as follows by *Engineering*:

The raw material, consisting of about 77% of chalk and 23% of clay, is brought by barges and deposited alongside



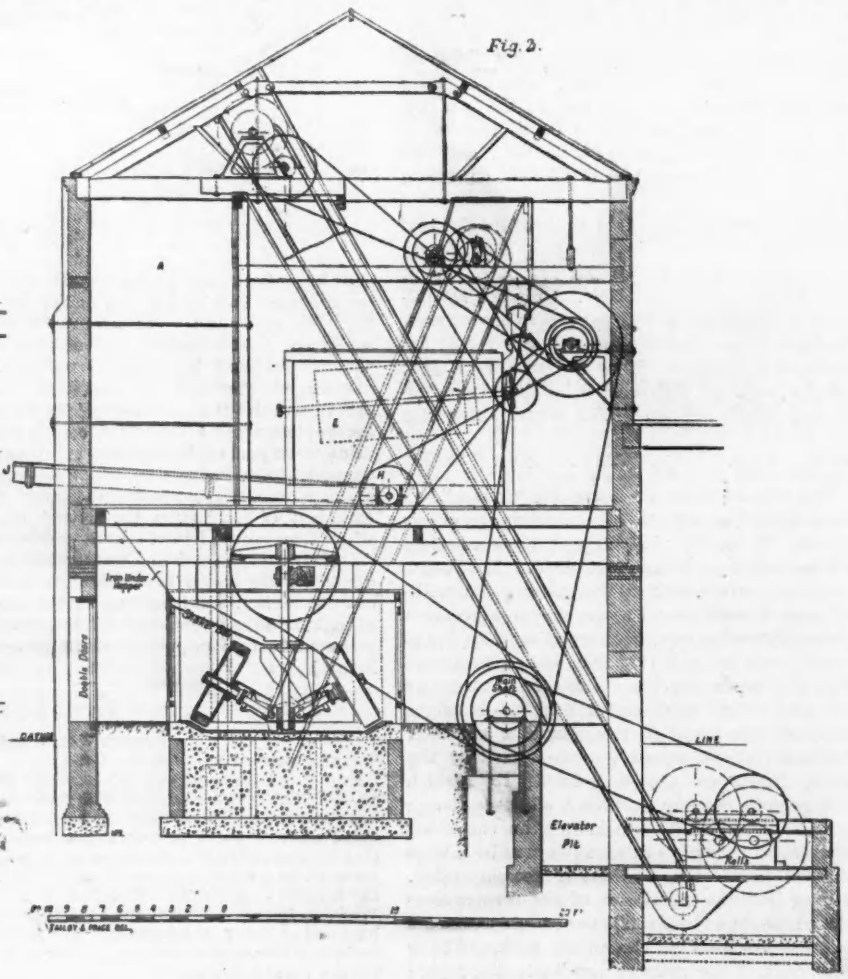


Fig. 1. Part Longitudinal Section. Fig. 2. Cross-Section.

A NEW PORTLAND CEMENT PLANT AT ROCHESTER, ENGLAND.

a wharf, from whence it is removed to two large wash-mills adjoining the river, and into these mills the materials are weighed. Heavy harrows break up the lumps of chalk and disintegrate the clay, about 25% of water being added. The slurry thus formed is driven, by the centrifugal wash of the harrows, through fine steel gratings and flows by gravitation through a channel into a pit, whence it is elevated by a large bucket wheel to a storage tank. Below this tank are ranged four pairs of 4 ft. 6 ins. French burstones, driven by mitre gear, and speeded to run at about 170 revolutions per minute. Sliding valves attached to the tank regulate the flow of the slurry to the stones, which thoroughly incorporate the raw materials and reduce them to the consistency of a smooth paste. The slurry, after being ground, gravitates to the suction pit of a set of three-throw plunger pumps of massive design, and is forced under considerable pressure through pipes to the other end of the factory, where the kilns are built. This plan of more or less isolating the wet mill has many advantages, but is chiefly adopted owing to the increased storage room obtainable for the raw materials. The slurry is burnt in large kilns constructed under the patents of Mr. G. H. SHELSEY, managing director of the works, having first been dried by the waste heat derived from the calcination of the previous charge. It is then drawn and loaded into wagons, this being the last time it is manipulated by hand until it is filled into sacks or casks in the warehouse.

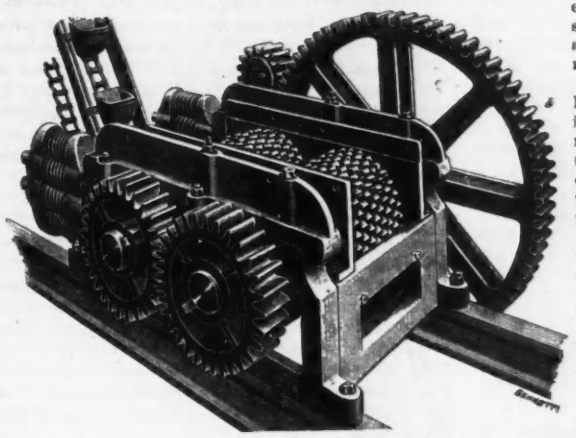


FIG. 3. CRUSHING ROLLS FOR PORTLAND CEMENT CLINKERS.

After leaving the kilns the clinker is wheeled in trucks to the crushing rolls placed outside the mill house, their position being indicated on the right side of Fig. 2. These rolls, of which Fig. 3 is an engraving, call for notice chiefly on account of their great strength and the massive springs which press them together. A heavy flywheel is provided, and sufficient belt power to take charges of a ton at a time without choking or slipping. From the rolls the crushed clinker gravitates to the bottom boot of an elevator, where it is picked up by buckets, as shown in Fig. 3, and discharged into the storage hopper *A* on Fig. 2. This hopper extends nearly the whole length of the mill.

The grinding proper is effected in a pair of large edge runner mills, one of which only is illustrated (Fig. 4). Each is provided with four runners gyrating on a fixed inclined bedplate (see Figs. 1 and 2). The runners being all of equal weight and set at an equal distance from the center, balance each other, and acting practically as fly-wheels, secure steadiness in running and an absence of friction. Special provision has been made for the exclusion of dust from all the working parts, especially in the case of the axle-boxes, where experiments have proved that ¾ lb. of grease of a special kind in each box will last through a heavy week's work. The toe step is provided with a similar arrangement, and if clogged can be cleaned from the outside of the mill. The mill is driven by a steel pinion and countershaft in vertically adjustable bearings, the fast and loose pulleys being arranged in such a manner that when the mill is standing and the belt is on the loose pulleys both belt and pulleys are still, and the weight of the lower loose pulley is completely taken off the main shaft. No lubrication is therefore necessary for either loose pulley, and the belt can be shifted from loose to fast, or *vice versa*, in a couple of seconds, although 12 in. in width.

Having received a preliminary crushing by the runners the clinker is carried by specially designed scrapers into the two pits *B B*, Fig. 1, whence it is delivered by the elevators into the hoppers *C C* and falls through the pipes *D D* into the two sifters *E E*. These sifters, which are the subject of a separate patent, are so constructed that the wire cloth forming the outer skin of the sieve is protected from injury by an inner lining of perforated steel plates forming a septagon, any side of which may be removed for cleaning or repair without disturbing the wire cloth on the outside. The material rejected by the sifters falls down the pipes *F F* into the center of the mill again to be reground, and the fine cement is collected and carried to the point *G* by the screw *H*, whence the second screw *J* takes the product of both mills into the warehouse.

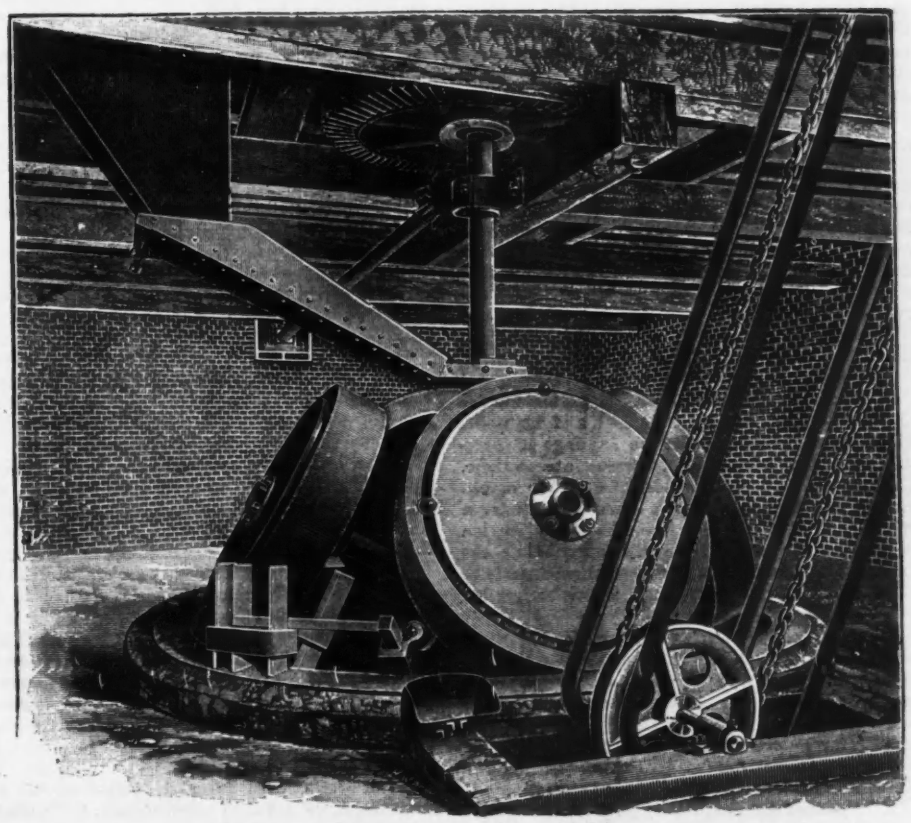


FIG. 4. MILL FOR GRINDING PORTLAND CEMENT CLINKER. CAPACITY, 3½ TONS PER HOUR.

The process is thus an automatic and continuous one, and the lubrication is so well worked out that the mill can run on for many hours without stoppage. The mill is said to turn out regularly from three to four tons per hour, according to the quality of the clinker, the average being over 3½ tons, and the fineness of grinding 5% on a 50-mesh testing sieve. This result could hardly be attained by four pairs of French burstones 4 ft. 6 ins. in diameter without the aid of expensive elevating and sifting machinery, as three pairs of stones only could be run at once, one of the four being always up for dressing. It is further claimed that the horse power per ton per hour is less than half of that absorbed by millstones for fine grinding. This mill is said to be equally efficient on lime, cement, flints, rock phosphates and basic slag, in the latter case giving extra facilities for the removal of nodules of iron owing to the long drop from the sifters to the mill. The whole of the plant was constructed at Mr. NEATE'S new works at Rochester.

Laws Regulating Taxation for Street Construction and Maintenance in American Cities.

A change in the laws regulating the assessment of citizens for street construction and maintenance having been lately discussed by some of our contempories, we have gathered together information on this subject from the chief cities of the United States. There is very considerable variety in the practice, and both our readers and ourselves are indebted to the courtesy of the several city engineers and other officials who have furnished the material for presenting a digest of this practice. We give an abstract of the contents of these answers by cities, with the authority, as follows:

New York City.—THOMAS F. GILROY, Commissioner of Public Works. The first pavements on new streets are paid for by local assessment on the lots fronting on the new pavement, except that the assessment for the area included in the street intersection is distributed on the lots on the intersecting streets for the distance of one-half block each way.

Repavements, repairs and maintenance of pavements are paid from appropriations raised by general taxation from year to year, except that in streets within the limits of grants of land under water, where the conditions of the grant require the grantees and their successors, the present owners, to maintain streets and pavements. In these cases the cost of one repavement can be assessed on the abutting property, and after paying such assessment the respective owners are released from all further obligations in respect to maintaining the pavement.

The cost of regulating and grading streets, setting curbstones and flagging sidewalks, is assessed on the abutting property in the same manner as cost of first pavements on new streets.

The cost of building sewers, drains, culverts and receiving basins is assessed proportionately on all the lots which drain into the sewer, culvert or basin. In some cases the cost of building new sewers in place of old ones, the capacity of which is no longer sufficient for the drainage of the land and of the buildings erected on it, is also paid for by local assessment on the property drained. The general repairs and maintenance of the sewerage and drainage system are paid for from annual appropriations raised by general taxation.

The law on this subject can be found in the "New York City Consolidation Act of 1882," the edition of which, however, is now practically exhausted. None are to be had for public distribution.

Philadelphia, Pa.—SAMUEL L. SMEDLEY, Chief Engineer and Surveyor. The property owner pays for the original cost of curbing, grading and paving the sidewalks. The grading and first paving of a street, and the street intersections, is paid for by the city. But the abutting property owners are then assessed for this actual cost in proportion to their frontage on the street. All reconstruction, repairs and maintenance are paid for by the city from the funds raised by general taxation.

By a decision of the Supreme Court of Pennsylvania, the assessments for municipal improvement cannot be collected against rural property. Hence, in these outlying districts, the city pays for Macadam or Telford pavement out of the general tax fund.

Sewers are built by the city; but abutting property owners are taxed at a uniform rate of $1.50 per foot of frontage, whether the drain is a 12-in. pipe or a

12-ft. sewer. Corner lots are allowed a reduction of one-third in frontage, but the allowance must not exceed 50 lin. ft. Water pipe is laid by the city; but a uniform charge of $1 per lin. ft. of frontage is collected from all abutting property owners. Gas pipes are paid for and laid without any specific charge to property owners therefor.

Private streets must be graded and paved, and all pipes laid, in accordance with city regulations and specifications. Otherwise the city may not accept them or maintain them. All private sewers must be built under city inspection, at the cost of property owners.

Full information can be found in BRIGHTLEY'S "Complete Digest of Laws and Ordinances, 1701 to 1887." 1,400 pp. Published by Kay & Bro., Philadelphia, Pa.; price $7.50.

Boston, Mass.—WILLIAM JACKSON, City Engineer, writes that the cost of city street construction and maintenance is paid for by the city from the general tax levy. Betterments can be levied on account of the laying out of new streets; but as a matter of fact these betterments are generally offset by land and grade damages.

Mr. JACKSON says further that an effort is now being made to change the laws governing street improvements so as to assess the expense of construction and maintenance upon abutting property.

The city of Boston publishes in a very handy form, "The Revised Ordinances of the City for 1890, and Revised Regulations of the Board of Aldermen for 1890." This is published by order of the City Council.

Buffalo, N. Y.—EDWARD B. GUTHRIE, Deputy Engineer. New pavements, grading, new sewers and sewer repairs are paid for by the property benefited. Repairs of pavements are paid for out of the general tax fund; but renewals of pavements are treated as new pavement and paid for by the abutting owners.

The tax levied for the above is per foot of frontage, except in the case of sewer tax. In the latter case, a portion is paid as frontage tax and the balance by a surface tax over the district benefited by the owner.

These taxes are fixed by the Board of Assessors, and city property is treated the same as individual property for purposes of new construction and maintenance. The city pays for all repairs to the pavements and for cleaning the same.

Providence, R. I.—J. HERBERT SHEDD, City Engineer. As soon as a street has been received and accepted by the city, the cost of construction and maintenance is paid for out of the general tax fund; except that the abutter pays the cost of the curbstone, which is set by the city, and the cost of furnishing and laying the sidewalk.

Baltimore, Md.—J. E. SUDLER, Consulting Engineer. Property owners on abutting streets pay for the whole of the construction of new pavements, and pay two-thirds of the later cost of maintenance, the city paying the other third.

The property is taxed per front foot, at a pro rata rate, not varying with the character of the frontage or location of the street, and as fixed by the total cost of construction.

In addition to the above matter furnished by Mr. SUDLER, the following abstract of a late address delivered by Lawyer WILLIAM L. HODGE, before the Taxpayers' Association of Baltimore, will be of interest in this connection.

Mr. HODGE said that all grading, paving and curbing of streets in Baltimore is now regulated by the act of 1874, and a general ordinance passed in the same year. Under the provisions of this law the Mayor and City Council may, by a special ordinance, grade, pave and curb or regrade, repave and recurb any street or alley, and assess the cost of this work in whole or in part upon the abutting property. No special ordinance is required if the owners of a majority of the feet of frontage apply for such improvement; but all abutting property must pay for this pro rata. The work itself is to be done by contract by the lowest responsible bidder. If the City Commissioner, with the approval of the Mayor, concludes to regrade, repave or recurb any street, the city pays one third of the cost of such improvement.

While the above is the law, Mr. HODGE says that the Court of Appeals has, by numerous decisions, almost totally changed and annulled the foregoing provisions, invariably with loss to the city, by payment from the general tax fund. The basis of the decisions referred to was, that the theory of the assessment of cost upon property owners was that the improvement was for their individual benefit, in enhanced value of property; and that they derived an advantage over and above that conferred upon the public at large. The courts held that the ordinance must be passed with this motive and for the purpose of conveying a special benefit upon such property, or else it is null and void. The particular ordinance ruled upon above recited in its preamble that "whereas the public convenience requires that Light St. should be paved, etc." This ordinance and all others which contained a similar preliminary declaration were declared null and void, and the city could not collect one dollar of the assessment levied.

This defect was remedied in subsequent ordinances by simply stating that the improvement was for the benefit of property owners, whether the actual fact was so or not. The Court of Appeals held that the propriety or necessity for such improvement rested exclusively within the discretion of the Mayor and City Council, and cannot be enquired into by the courts. In 1884 an ordinance was passed compelling the Mayor and City Council to submit to the City Solicitor any ordinance proposed for grading and paving or regrading and repaving any street. It was to be carefully examined and a written opinion given upon its legal sufficiency before passage.

Mr. HODGE recommended that at least one-half of the entire cost of grading and paving be paid by the city out of the general tax, thus leaving one-fourth to be paid by the owners on each side of a street. He says the present tax upon property is out of all proportion to individual benefits conferred. The speaker also recommended that a rule be adopted that no one be eligible for the office of City Commissioner except a qualified civil engineer, and that the present pay be doubled. He also said that a general system of city grades should be secured and definite lines for streets fixed upon and adhered to, etc.

Cincinnati, Ohio.—H. J. STANLEY, Chief Engineer.* The tax for street improvements in this city is levied as follows: For all streets, except those paved with granite and asphalt, the city pays 2% on the gross cost. The remaining cost is divided by the whole number of abutting feet of property frontage, and the resulting pro rata assessment is collected from the abutting owners. The city pays, as an abutting owner, for lateral street connections or for street intersections.

This frontage tax can be paid in cash on completion of the improvement; or in ten annual instalments, with 5% interest on deferred payments.

In the case of granite and asphalt pavements the city pays one-half of the entire cost, and no more. The other half is assessed on the frontage of abutting property, exclusive of street intersections. These payments can be made in cash, or in ten annual instalments as above described. Under a special act of the legislature, the city's portion is provided for by the issue of bonds. While the practice last described has been confined strictly to granite and asphalt pavements, it can be applied to other classes.

Under the same act the contractors for the work are required to keep the pavements in good condition for five years, on granite and asphalt improvements, and on other classes of paved streets, two years. From the final estimate 10% is retained as security for repairs in each case. After the repair term expires the city makes all further repairs from money appropriated from the general tax fund.

In the case of sewers the city pays from a special fund all cost in excess of $2 per front foot of abutting property. The present average cost of these improvements per front foot is as follows: Granite, $6.50; asphalt, $5; $6.50 for bowlders and $5 for macadam. The granite and asphalt is figured at half cost in the above, and more or less grading is included in this cost.

Mr. STANLEY kindly includes the following table of cost per square yard for road covering, including excavation for rolling, subgrade, etc., complete: but not including curbing, flag gutters and crossings:

Class of Pavement.	Per sq. yd.
Granite block, 6 ins. cement concrete foundation	$4.25
Sheet asphalt, 6 ins. cement concrete foundation	3.25
Brick, 6 ins. cement concrete foundation	2.50
Bowlder, 12 ins. compacted macadam foundation	2.25
Macadam, 18 ins deep, in several layers.	1.25

Milwaukee, Wis.—G. H. BENZENBERG, City Engineer. The tax for street improvements here is levied upon abutting property, for the whole cost of such improvement. This tax is usually equal to the actual cost of the work, based upon the prices for which it is let by the Board of Public Works. After the improvement has been ordered made by the Common Council, an assessment is made by the Board of Public Works, when viewing the property. The actual tax is usually a trifle below this assessment. The tax is paid by the property owner, with other general and special taxes, in December and the January following of each year.

The original cost of any street improvement, whatever it may be, is assessed against abutting property. The exceptions to this rule are the street and alley crossings, which are paid for out of a so-called ward fund, derived by a general tax against all property, real or personal, within the limits of the ward. The maintenance of such roadway is paid for out of this ward fund.

If, in the progress of time, the street or roadway is paved, such pavement is in like manner paid for by the property fronting such street, less the amount that the property has paid for in the paving of gutters in the first improvement, which expense is payable out of the ward fund. After a street has once been paved all expense thereafter of maintenance or reconstruction is paid for out of the above named ward fund. All crossings, however, are paid from the beginning to the end of construction or maintenance by the ward out of its fund. The tax for such street improvement does not vary with the character of the fronting street or the location of such street, but only with the character or amount of work.

All other classes of street improvements like laying of water-mains, sewers, drain connections, water service pipes, etc., are paid for by the property in front of which such improvements are made; limited, however, in the case of water-mains to one-half the cost of a minor or six-inch water-pipe laid in the street, and in the case of sewer mains not to exceed 80 cts. per running foot, with deductions of one-third front at the corner lots.

St. Paul, Minn.—L. W. RUNDLETT, City Engineer. The first cost of all local improvements, such as street grading, pavements and sidewalks and curbing, is paid for by abutting property owners, pro rata, per front foot. This includes street crossings.

The city pays no part of this first cost, but pays the entire cost of maintenance. When new construction is necessary the cost is assessed upon the abutting property, as in the case of the first improvement.

No discrimination whatever is made as to the character or cost of abutting property. But occasionally, when a street is graded into a rural district the assessment is carried for a block or two each side of the improvement, and graduated off as the property is further away from the improvement.

The maximum assessment for sewers is $1.75 per front foot. All excess in cost is paid for out of the Sewerage Bond Fund.

St. Louis, Mo.—GEORGE BURNET, President Board of Public Improvements. In this city the total cost of street improvements, including all street intersections, is paid for, per foot of frontage, by abutting property owners. The cost of alley construction, including entrance, is paid for by the property and assessed in a similar manner.

But if the amount assessed against any lot exceeds 25% of the assessed value of said lot, the city pays all cost above this 25%. The city also pays for the grading and the crosswalks. In the case of the entire reconstruction of a street, including grading and crosswalks, the same rule applies as above—viz., the entire cost, except the excess over 25% of the assessed value of lot, is paid for by the property owners.

The city pays for all maintenance of roadways of streets. But the sidewalks are paid for by a special tax against the fronting property, each lot being assessed for the repairs actually made in front of it. Alley repairs are paid for by a similar special tax against the property, except that repairs to the entrance of alleys are paid for by the city.

* Owing to recent political changes Mr. STANLEY no longer holds this office.

Machines for Boring Angular Holes.*

If the axis of a drill spindle is moved in a closed path while the drill itself is revolving, then the resulting hole will have an irregular outline. The motion of the axis may be such that the spindle remains always parallel to its original position, or it may have a pendulous and rotary movement simultaneously.

In a machine with a parallel motion, the drill is moved much as in ordinary borers, while in the pendulous class the entire tool frame moves relatively to the work. In the latter class the size of the hole naturally depends upon the distance between the cutting edges of the drill and the point of suspension of the frame if the amount of oscillation is fixed, while in parallel-motion borers a separate cam is necessary for each size of hole. In this regard, the pendulous machine must be regarded as the better. But the small actual cutting edge of the tool in such arrangement, as compared with the double edges which cut simultaneously in the ordinary machine, makes its actual efficiency much less.

In the Ainley-Oakes square drilling machine, Figs. 1-5, a cylindrical sleeve, *C*, is revolved by bevel gears, *B*, which are connected with the driving cone by a shaft running through the frame, *A*. In this sleeve is another hollow cylinder, *D*, capable of being moved vertically and containing the actual drill spindle, *E*; all the parts, which are held by keyways and feathers, being revolved by the gears.

The drill spindle can be moved vertically by means of the adjusting screw, *F*, and also by levers in the usual manner, the connection between *E* and *F* allowing a slight lateral motion. At the upper end of the sleeve *D* is a ring, *G*, free to turn on, *D*, and connected by a link with the lever, *K*, moving in a quadrant, similar to those on locomotives. By means of this lever, the drill can be fixed at any desired height.

Two guide plates, L_1 and L_2, control the lateral motion of the sleeve *D*, the motion naturally being greater for large than for small holes. There are 5 cams, each $^9/_{16}$ of an inch thick, attached to the sleeve *D* at each end, and, by raising or lowering the ring, *G*, the cam corresponding to a hole ½, ⅝, ¾, ⅞ or 1 in. in diameter is brought to bear against the plates.

These cams, Figs. 3 and 4, *N*, have the form of a triangle with curved sides, while the guides have the same form as these holes to be bored. The guide plates are

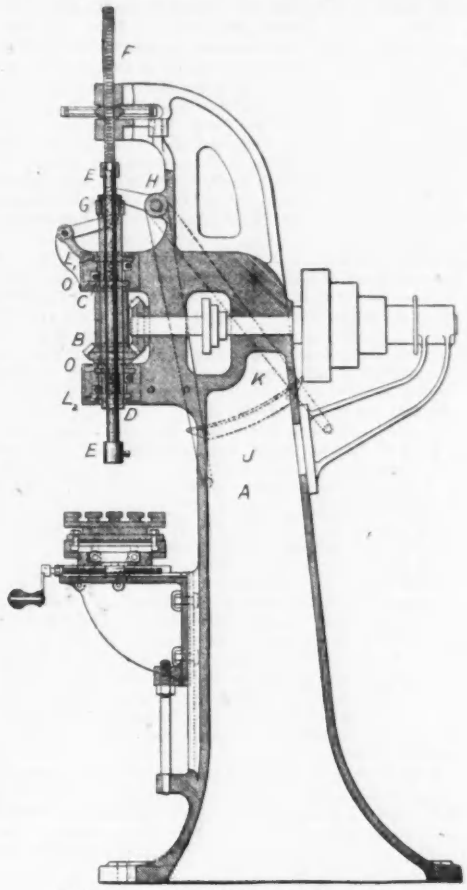


FIG. 1. THE AINLEY-OAKES DRILL.

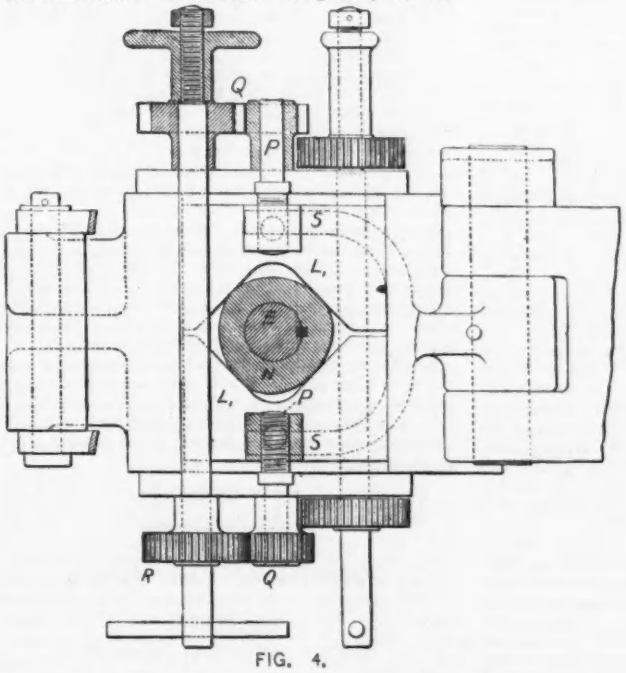


FIG. 4.

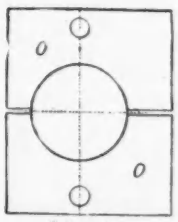


FIG. 2.

FIG. 3.

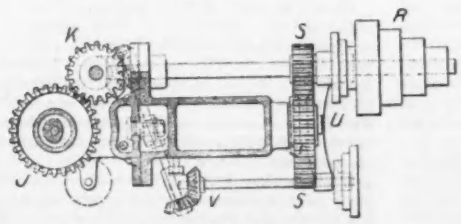


FIG. 7.

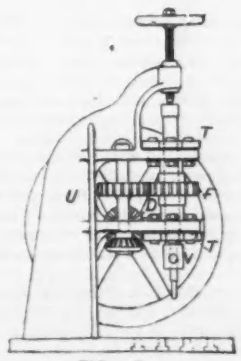


FIG. 5.

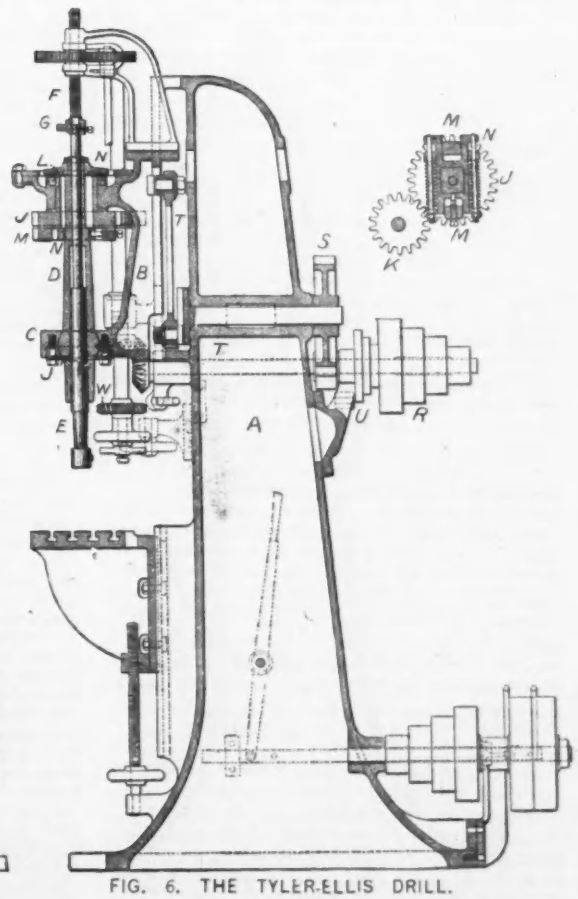


FIG. 6. THE TYLER-ELLIS DRILL.

double, the two halves being moved in or out to accommodate the different sizes of cams, by the gearing *R Q*, screws *P* and nuts *S*.

The machine is adjusted by raising the proper cam for the hole desired to a level with the guide-plates, and then bringing the latter to a contact with the cam. In order to bore a circular hole, the guide plates, *L*, are run out and another set, *O*, Fig. 2, adjusted around the sleeve where it has a circular cross-section. A recent modification is shown in Fig. 5, where guide rolls, *T*, are substituted for the guide plates, and the bit is driven by a set of gears, *D*, *U* and *F*.

In the Tyler-Ellis machine, Figs. 6 and 7, a frame, *B*, slides vertically on the face of a support, *A*, and carries the boring sleeve, *D*, by a ball and socket joint at *C*. In this sleeve is the drilling spindle, *E*, connected with the adjusting screw, *F*, by a universal joint, *G*. At the upper end of the sleeve, *D*, is a cam, *N*, which travels around the inner edge of an annular template, being pressed outward by a pair of spiral springs.

In the head of the borer is a gear, *J*, driven by the cone, *R*, through the rods and gear, *K*. Attached to the gear, *J*, are small lugs, *M* (see small cut), over which a frame, *N*, is moved. This frame is connected to the lugs by springs in such a manner that it gives to the pressure caused by the cam, *N*, Fig. 6. For a definite form of hole, only one cam and template is necessary, the different sizes being obtained by raising or lowering the drill by the adjusting screw, *F*.

It is interesting to note that the machine can also be used as a punch. The frame, *B*, is then given a reciprocating motion by the gear, *S*, and the rod, *T*. The boring spindle is turned by a belt connecting the small cones, *U* bevel gears, *V*, and worm gear, *W*, Fig. 7.

*Abstract of an article in *Dingler's Polytechnisches Journal* of Jan. 2, 1891.

River Pollution in the United States.*

This paper is presented to the club as a résumé, as complete as may be, of the work that has been done in this country in determining and showing to what pollution our streams are subject, to call attention to the importance of the subject, and, if possible, to excite discussion.

I have been engaged more or less of the time for two years in determining the amount and sources of pollution of various streams in the State of New York, and have seen clearly the great and growing importance of a thorough awakening of the people upon the subject, and the desirability of discussion as to the best methods of preventing the increase of pollution, and in many cases of reducing the amount of polluting matter now entering certain streams. I am quite selfish in the matter, as well as solicitous for the improvement of the streams, as I am at present engaged upon the investigation of the watershed of one of our great rivers, and want all the light I can get before beginning the final discussion of results.

The streams have divided themselves in my mind into three classes: 1. Those that are used as sources of water supply, and are evidently to be used for this purpose alone. These can readily be disposed of, and are in the State of

* A paper by CHARLES C. BROWN, read before the Engineers' Club of St. Louis, and reprinted from the *Journal of the Association of Engineering Societies* for October, 1890.

New York, by the methods used for the Croton River and described in my paper before the club last year.† 2. The streams which cannot be used for water supply, and can, in many cases, be used as drainage channels. The principal question with this class of streams is as to the amount of polluting materials which can be allowed to enter them without producing nuisance or interfering with life or property in them. There has been some discussion of this portion of the subject, and maximum limits of pollution have been assumed by some authorities upon the basis of obtainable information as to the effect of given amounts of polluting matter (estimated with greater or less accuracy) upon a stream of a given flow. 3. The streams which are in use as sources of water supply for domestic purposes, and are at the same time used as drainage channels into which all sorts of filth are discharged. The greater number of our larger rivers and many of the smaller ones belong to this class. While theoretical considerations demand the rigid exclusion of most kinds of artificial pollution from streams used for potable water supply, it is practically true that these considerations are lost sight of in very many cases, and in a large proportion of these cases with little or no apparent evil effect, though the evil effects are quite noticeable in some cases. Aside from the statement of and argument for the theoretical considerations referred to, the discussion of this branch of the subject is very limited. It is, practically, the most important, because the largest branch of the subject, and a practical discussion, with as many data as can possibly be obtained, is very much needed.

I will confine this paper as closely as possible to this third division, and, as the title of the paper indicates to work done in this country.

Some work has been done in several States. Of these, I have some knowledge of that done in Maine, Massachusetts, Connecticut, New Jersey, Pennsylvania, New York and Illinois. It is probable that some work has been done in other States, and, if so, I shall be very glad to add the results to the data I have on hand, and shall feel much indebted to any who can supply them.

The work done in Maine, as given in the reports of the State Board of Health, is entirely chemical in its nature, and consists of analyses of samples of the waters supplied to villages and cities by the various water companies and corporations in the State. All the water supplies in the State are represented, but two, by several samples taken at various times of the year. Those of interest to us in the present discussion are those from rivers. But few corporations in Maine take their supplies from rivers; more take them from lakes and ponds which are usually with small watersheds and with little population to produce dangerous pollution. The average results of the examinations of supplies from rivers are here given.

All results of chemical analysis in this paper are reduced to parts per 100,000.

Cities.	Augusta.	Bangor.	Biddeford and Saco.	Brunswick.	Calais.	Lewiston.	Waterville.
No. of samples.	5	3	6	3	6	5	4
Total solids	3.7	4.4	2.8	3.8	3.6	3 8	3.3
Loss on ignition	.1	2.7	1.5	2.0	2.5	2 4	2.1
Hardness	1.99	1.86	1.08	2.03	1.59	1.65	1.75
Chlorine	0.2	0.16	0.26	0.1	0.27	0.2	0.26
Free ammonia	0.0152	0.0063	0.0001	0.008	0.0005	0.0005	0.0007
Organic a'm'n'a	0.0552	0.0183	0.0128	0.0153	0.0268	0.0158	0.0155

In none of the samples is there more than a trace of nitrites or nitrates. None of the water-sheds are densely populated, and all seem, from the standpoint of the analyses and from a consideration of the amount of population, to be quite free from danger. The same can be said of the systems drawing their supplies from brooks and lakes. The following were taken on June 7 and 8, 1888, as a beginning of a series to show the fluctuations of pollution in the river waters, but the series was interrupted, and the few here given are all that have yet been published. They are too few in number to be of much value. No. 130 is from Carrabassett River, at the village of No. Anson; No. 131 is from Kennebec River; No. 132 ditto below the city sewers; No. 133 is from Moosehead Lake; No. 134 is from Kennebec River, and No. 135 from Dead River just above the Forks. "No deductions can be made from the results of the analyses, particularly from the two samples collected from the Forks, for the water was very high at the time and the streams were crowded with logs."

No.	Total solids.	Loss on ignition.	Hardness.	Chlorine.	Free ammonia.	Organic ammonia.	Nitrites.	Nitrates.
130	2.8	1.8	1 27	0.2	0.000	0.012	None.	Slight trace
131	3.4	2.4	1.56	0.3	0.000	0.013	"	"
132	3.4	2.4	1 69	0.3	0.000	0.014	"	"
133	3.0	2.4	1.56	0.2	0 000	0.013	"	"
134	3.8	2.6	1.27	0.4	0.000	0.017	"	"
135	4.2	2 0	1.43	0.3	0.003	0.022	Slight trace	"

† "The Sanitary Condition of the Water Supply of New York City." Read April 17, 1889, and published in the *Journal of the Association of Engineering Societies* for July, 1889.

Nearly or quite all of the waters here examined belong to the first class of waters, those that can be used without question for water supply if ordinary precautions are followed, as the population on the water-sheds is comparatively sparse and is not subject to great concentration in large cities. The results are of interest for purposes of comparison.

The State of Massachusetts has done more work on the investigation of the pollution of rivers than any other State. The work in this State has proceeded at a greater or less rate since the year 1873, and quite a mass of data has been obtained which is being added to each year. I have time to make only a very condensed statement of the results of these investigations as they have been published. I will try to make this statement as clear as possible in so far as the work done has a bearing on the principal subject of this paper. I would refer to the reports of the State Board of Health of Massachusetts for the detailed results, especially those of 1874, 1876, 1886, 1887, and 1888 supplement, and the reports of the Massachusetts Drainage Commission.

The principal rivers examined are the Merrimack, Blackstone, Chicopee, Taunton, Charles, Sudbury and Concord, Neponset, and other sources of supply for the Boston water-works. The Merrimack is used for sewerage and mill drainage as well as for water supply; the Blackstone is not used to any considerable extent for water supply, but is small enough to become somewhat of a nuisance from sewage and mill drainage. The others are small and portions of them come under both the above classes.

The examinations were made by chemical analysis and by actual count of the principal sources of pollution, such as sewerage systems of villages and cities, and refuse, solids and liquids, from mills.

The following table gives the results of examinations of the Merrimack at different points. It is taken from W. R. Nichols' report of 1874, and shows the variation in the relative amount of pollution at different points. The table is followed by an abstract of Mr. Nichols' interpretation of the results:

	Mean of 11 examinations above Lowell.	Mean of 12 examinations above Lawrence.	Mean of 11 examinations below Lawrence.
Ammonia	0.0047	0.0044	0.0031
Albuminoid am'onia	0.0114	0.0110	0.0127
Inorganic	2.37	2.41	2.64
Organic and volatile	1.73	1 69	1.79
Total solid matter	4.10	4.10	4.43
Chlorine	0.14	0.20	0.18

The first column gives results above the great sources of pollution, the second below one, and the third below two. The question arises as to what becomes of the vast amount of polluting matter which is known to enter the river.

1. Oxidation is shown by the individual results to be an agency of almost no effect in disposing of the polluting matter. The effect is too small to be measured.

2. Deposition doubtless removes a very large proportion of the matter from the water. This deposition is of the insoluble matter which may be so at time of entrance, or be made so by chemical action, especially in the case of discharges from mills. These deposited materials, in the case of the streams of the class of the Merrimack, are taken up by floods and swept on down the stream, or are covered by other sediment in the form of earth or similar matter and are thus purified or removed as a source of danger.

3. Dilution is a great reducer of the proportional amount of pollution. It was estimated in 1873 that, at the minimum stage of the river, it would be necessary to discharge 100 tons of dry soluble matter into the river per day to increase the amount of solid matter in solution by one grain per gallon, and that the amount of chlorine discharged into the river was 400 tons per annum, or but little more than one ton per day. It will be observed that the amount of water entering the river from less polluted sources, between the points of observation above and below Lawrence, is sufficient to reduce the proportional amount of chlorine in the water. This effect must be laid to dilution as the compounds of chlorine to be found under these circumstances are almost or quite all soluble.

Other examinations of the river were made in 1879 and 1886. The caution is given that the results are not sufficiently numerous to insure that the average condition of the water each year of examination is obtained, and that if this average condition has not been obtained, the results are not strictly comparable. The following table gives the averages of the results for the three years, and is of interest as showing the increase in the relative amount of pollution with the increase in population and in number of mills. This table is taken from the report of Mr. F. P. Stearns in the State Board Report for 1887.

Place.	No. Exams.	Date.	Ammonia.	Albuminoid ammonia.	Chlorine.	Residue. Fixed.	Residue. Volatile.	Residue. Total.	Hardness.
Above Lowell	11	1873	0.0047	0.0114	0.14	2.37	1.73	4.10	
" "	7	1879	0.0047	0.0131	0.40	2.00	2.50	4.50	
" "	2	1886	0.0031	0.0155	0.35	1.95	2.15	4.10	1.00
Below "	2	1873	0.003-	0.0198	0.20	2.64	2.39	5.03	
" "	4	1886	0.0034	0.0176	0.39	2.55	2.07	4.62	1⅛
Above Lawrence	17	1873	0.0044	0.0110	0.20	2.41	1.69	4.10	
" "	6	1879	0.0018	0.0131	0.44	4.62	2 94	7.56	
" "	4	1886	0.0066	0.0173	0.41	2.78	2 20	4.98	1¼
Below Lawrence	9	1873	0.0030	0.0130	0.18	2.61	1.73	4.34	
" "	9	1886	0.0138	0.0244	0.46	3.22	2 15	5.37	1¼
Above Haverhill	6	1873	0.0033	0.01 4	0.18	2.78	2.04	4.82	
" "	2	1886	0.0058	0.0207	0.44	3.26	2.39	5.65	1¼

As an aid to the understanding of these results the following facts are stated:

"The distance between points above and below Lowell where samples were taken in 1886 is about 3½ miles. Within this distance the river receives the refuse from the mills, the sewage of the city of Lowell (population in 1873, 46,000; in 1879, 58,000; in 1886, 65,000), and the flow from Concord River and Beaver Brook, which combined have a drainage area about ⅛ as large as the Merrimack River at Lowell. In the latter part of the distance the water flows over some rapids known as Hunt's Falls, falling about 11 ft. From the sampling place below Lowell to above Lawrence the river flows without noticeable fall, and receives very little addition to its volume. From above to below Lawrence the distance is 2.2 miles. In this distance the water falls about 30 ft., is increased in volume from 1 to 2% by the addition of the Spicket River and receives the drainage from the mills and from the city of Lawrence. The population of Lawrence in 1873 was 33,000; in 1879, 38,000; in 1886, 39,000. From the place of sampling below Lawrence to the one above Haverhill is 6¾ miles. In this distance the Shawshine River adds one or two per cent. to the volume of the larger river and the water falls a few feet in rapids."

Judging by the results for albuminoid ammonia and chlorine, there is a marked increase in the amount of pollution with the time. The indication of this is sufficiently strong to admit of no question. The indication of an increase in pollution down stream is equally decisive. There is evidently a decrease in pollution during the time that the water is flowing from one city to the other, during which time it receives no additional pollution, but there is enough remaining to make with the increase by the drainage of the lower city a larger quantity than before. In other words, the purifying action during the flow of the river between the two cities is not sufficient to remove a very appreciable amount of the pollution. Below Lawrence, where the river receives some additions as well as flowing a greater distance, the purifying and diluting effect is no more strongly marked.

These results bear out the statements of the Rivers Pollution Commissioners of England, and show as clearly as such rather meagre results can that the pollution of our rivers that run through populous districts, especially manufacturing districts, is cumulative, and that unless there are appreciable accessions of water from unpolluted sources, the river will purify itself but slightly.

Results for 1887, published in the report for 1888, show about the same amount of total solids, but differently distributed, the amount of volatile matter being less than in 1886. The amount of chlorine is also less by 30 to 50%, but the results show the same tendency to an increase of pollution as we go down stream.

(To be continued.)

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Hoosic Tunnel & Wilmington.—This company has petitioned the Massachusetts State Legislature for power to increase its capital stock to $250,000, and to consolidate with the Deerfield Valley R. R. Co. The road now runs from Hoosic Tunnel to Readsboro, Vt., 11 miles, and it is proposed to extend it 14 miles farther to Wilmington, Vt. The proposed extension is estimated to cost $130,000, of which $45,000 have already been subscribed by the people along the route.

Western New York & Pennsylvania.—The surveys have been completed for the extension from Summit Station, between Mercer and Jackson Centre, Pa., to Oil City, Pa., and it is announced that work will begin at once.

Western Maryland.—Rogers & McDonald, of Baltimore, Md., have the contract for building the Potomac Valley R. R. from Williamsport, Md., to Cherry Run, W. Va., 14.3 miles. The roadbed is to be first class in every respect, with steel rails and stone ballast. There will be

iron bridges over Conocoheague Creek and the Potomac River.

Western Virginia Central & Pittsburg.—Surveys are now in progress for a line from Cumberland to Williamsport, Md.

Franklin & Megantic.—A bill is before the Maine Legislature incorporating the Canadian & Maine R. R. Co. to build an extension of this railway from Kingfield, Me., north.

Delaware, Susquehanna & Schuylkill.—W. E. Hawley & Co., Pittsburg, Pa., have the contract for grading the 14-mile section from Hazleton to Shamokin, Pa.

Catasauqua & Fogelsville.—Surveys are reported in progress for an extension from Catasauqua to Nazareth, Pa.

Projects and Surveys.

Ontario, Belmont & Northern.—Application has been made to the Ontario Legislature for a charter to build a railway by this name to the iron mines of Hastings and Petersborough counties.

Plymouth & Middleboro.—Arrangements have been completed whereby the Old Colony R. R. Co. agrees to take a large portion of the stock of this company, and to operate the road for a certain percentage of the earnings. About $66,000 have been subscribed in aid of the road by the towns of Plymouth and Middleboro, and $20,000 additional will be raised by the people. It is expected to have the line completed within a year.

Penobscot Central.—This company has filed plans showing the location of its line. The road will run from Bangor, Me., via Glenburn, Kenduskeag, Corinth and Charleston, to Milo, Me. It is stated that work will begin this spring.

Seneca Co.—The officers of this company, whose incorporation was noted in our issue of Feb. 28, are: President, James H. Gould; Vice-President, Wm. L. Sweet; Secretary, Chas. A. Hawley; Treasurer, Geo. T. Thomas. Surveys will be made at once.

SOUTHERN.—Existing Roads.

Savannah, Americus & Montgomery.—About 1,500 men and 500 teams are now at work on the line from the Chattahoochee River to Montgomery, Ala., 80 miles. Twenty-five miles of track are already laid.

Georgia, Carolina & Northern.—The large iron bridge over the Savannah River has been completed and tracklaying will begin at once on the line west of the river. It is expected to have the line completed to Elberton in 6 weeks.

Gainesville, Tallahassee & Western.—It is reported that grading has been begun upon this Florida railway.

Chattanooga Southern.—It is stated that this company has decided to build a branch from Leesburg, Ala., to a point on the East & West R. R. of Alabama.

Union Central.—This company will erect a union station at Memphis, Tenn., to cost $300 000.

Richmond, Nicholasville, Irvine & Beattyville.—This company has made arrangements for the sale of its bonds, and the extension to Beattyville, Ky., will be built soon.

Tennessee River, Asheville & Coosa.—A press dispatch states that about 20 miles of track have been laid on this Alabama railway.

Empire & Dublin.—The grading on the extension from Hawkinsville to Grovania, Ga., is completed, and the rails are on the ground.

Georgia Southern & Florida.—Work on the line from Tipton to Thomasville, Ga., is making good progress.

Baltimore & Ohio.—A narrow-gage road 12 miles long has been built, connecting this road at Edinburg, Va., with the Columbia and Liberty furnaces. It is intended to further extend the road into the timber and coal regions of West Virginia.

Richmond & Danville.—It is reported that this company will extend the Manassas Branch west from Strasburg to the coalfields of West Virginia.

Middlesborough Belt.—The contract for building the various extensions of this road has been let to Walton, McFarland & Co., of Knoxville, Tenn. The total length of new line will be 9¼ miles, including 4½ miles on the Bennett's Fork Branch, 2½ miles on the Cabin Fork Branch and 2¼ miles of branches to coal mines.

Projects and Surveys.

Helenwood & Middlesborough.—Chartered in Tennessee to build a railway from Helenwood, Tenn., to Middlesborough, Ky., about 55 miles.

Lehigh Coal & Mining Co.—A railway is projected by this company to connect the mines of this company, at the Falls of New River, Tenn., with Ellenwood Station, on the Cincinnati, New Orleans & Texas Pacific R. R.

Mobile Transportation Co.—This company contemplates the construction of a railway from Mobile, Ala., south to Cedar Point. R. K. Warren, Mobile, Ala., President.

Birmingham, Mobile & Navy Cove Harbor.—A press report says that construction will soon commence on this road. The company was chartered some years ago to build a line from Mobile, Ala., along the east shore of Mobile Bay to Navy Cove Harbor, a distance of 35 miles. Thaddeus McNulty, of Mobile, Ala., was General Manager.

Bayard, Petersburg & Moorefield.—The line of this road between Moorefield and Germania, W. Va., is now being located. Construction will begin as soon as the location is completed.

New River & Kanawcha.—Chartered in West Virginia to build a railway from a point near the mouth of Dunn Loup Creek, in Fayette Co., to the Chesapeake & Ohio R. R., at Deepwater, W. Va. Among the incorporators are: Wm. Sharp, Malden, W. Va., and J. W. St. Clair, Fayetteville, W. Va.

Columbia Hotel & Belt Ry.—This company has been chartered to build a line of railway in North Carolina. Among the incorporators are: J. T. Wilder, Johnson City, Tenn., and F. T. Sanford, Augusta, Ga.

Augusta & Chattanooga.—The Piedmont Construction Co. has been organized to build this railway. R. M. Mitchell, Augusta, Ga., is President, and Allen D. Chandler, of Gainesville, Ga., is Secretary, of the construction company.

NORTHWEST.—Existing Roads.

Winona & Southwestern.—D. M. Wheeler, Winona, Minn., Chief Engineer, sends us the following:

The statement in your issue of Feb. 28 that this line is under contract to Mason City is incorrect. Contracts have been let and the work is nearly completed to Osage, Ia. The line will be extended from this point, but whether it will be to Mason City or not has not been decided. A decision will be reached and the contracts for construction will be let this spring. Work on the 1,300 ft. bridge at Winona is making good progress, about one-half of the ironwork for the east span now being in position and the trestle approaches completed. The Union Bridge Co., of New York City, has the contract.

Illinois Central.—The Chicago, Madison & Portage R. R. Co., has been chartered in the interest of this company to build a railway from Madison to Portage, Wis., 40 miles. Among the incorporators are: R. C. Falconer, Thos. Armstrong, Jr., and A. J. Turner, all of Portage, Wis.

Chicago & Eastern Illinois.—A dispatch says that this company will extend its line from Tuscola to Pana, Ill., where connection will be made with the Cleveland, Cincinnati, Chicago & St. Louis R. R. The two companies will run through trains from Chicago to St. Louis, Mo.

SOUTHWEST.—Existing Roads.

Choctaw Coal & Ry. Co.—A press dispatch from Fort Reno, Ind. Ter., says:

The Choctaw Coal & Ry. Co. is pushing the construction of its connection with the Santa Fé road at Oklahoma City. The construction train is carrying material from their yards here daily for the tracklaying. The purchasing agent states that an order has just been filed with a mill at South McAlister, on the Choctaw road, for 300,000 ft. of bridge timber to complete the preparation of track laying between here and Oklahoma City.

St. Louis, Chester & Grand Tower.—At a recent meeting of the directors of this road it was decided to resume work as soon as possible.

New Orleans & Northwestern.—The contract for grading the line from Rayville north to Oak Ridge, La., has been let to A. Heffner Oak Ridge, La.

Projects and Surveys.

Red River & Southwestern.—The survey has been completed for this line from Henrietta to Archer City, Tex.

Fort Worth & Denver Terminal.—This company will issue $500,000 of bonds, the proceeds to be used in building its proposed belt line at Fort Worth, Tex.

Amarello & Panhandle City.—A company will be organized to build a railway from Amarello to Panhandle City, Tex.

Memphis, Rogers & Western.—An application has been made for a charter to build a railway from Rogers, Ark., to Bald Knob, Mo. It is stated that the money necessary to make the surveys has been obtained, and that they will begin at once.

ROCKY MT. AND PACIFIC.—Existing Roads.

Union Pacific.—This company is endeavoring to renew the subscriptions of the various towns along the route in aid of the Portland & Puget Sound R. R., preparatory to commencing work.

Port Townsend Southern.—Bids have been asked for constructing the section between Union City and Olympia, Wash. About 200 men are working on the section between Lake Hooker and Quilcene.

Great Northern.—The contracts for clearing the right of way of the Pacific Coast extension have been let to Pend d'Oreille Falls, and location is in progress between that point and Spokane Falls.——Tracklaying will soon begin on the Seattle & Montana R.R.——Surveys are in progress for a line from Arlington to the Silver Creek mines, Utah.

Northern Pacific.—A press dispatch says:

The Northern Pacific will shortly begin some extensive construction operations on the western end of its line. A party of engineers is now engaged making a permanent location for the proposed new tracks from Coulee City to Waterville, and it is expected the Washington Central will be in readiness for operation to the latter point by the time next season's crop is harvested along the Big Bend. From Waterville west to Wenatchee only 25 miles of road will be necessary to connect the two lines, and the comparatively short distance will make the completion of the matter easier than otherwise. Surveying parties have also been sent out to locate a route from the head of Moses Coulee to the Okanogan mines. A line has been surveyed up the Columbia River, but it turns out to be somewhat more difficult than was expected, and the exact route is not yet determined. Another extension contemplated is a line from Lewiston to Camas Prairie.

Coos Bay, Roseburg & Eastern.—Work is making good progress on this Oregon railway. The roadbed has been graded for 30 miles along the Coquilla River from Marshfield east.

Rio Grande Western.—Grading has been resumed on the Sevier Valley Branch under the direction of H. T. Reynolds & Co., who have the contract for the first 25 miles south of Manti, Utah.

Projects and Surveys.

Albany & Astoria.—Surveys will be made soon for 28 miles of this road between the Mecanicum and Tillamook and Seaside, Wash.

CITY TRANSIT.

Electric Railways.—New lines or extensions are reported as probable in the following places: Auburn, Cal., address the B. & H. Electric Co.; Asheville, N. C., address F. Reynolds, Charlotte, N. C.; Vancouver, B. C.; Harlem, Ill., address the Cicero & Proviso Ry., of Chicago, Ill.; Cincinnati, O., address the Cincinnati Street Ry. Co.; Sandwich, Mich.; Salem, Va.; Abilene, Tex.; San Francisco, Cal., address T. J. Laumeister; Pittsfield, Mass.; Charlottesville, Va., address W. J. Ficklin; Louisville, O., address J. B. Speed.

Leominster, Mass.—It is reported that $50,000 has been subscribed for an electric rail way to North Leominster.

Pawtucket, R. I.—The Interstate Ry. Co. has been given authority by the House to construct an electric, steam or horse railway from the Massachusetts line to East Providence and this city.

Buffalo, N. Y.—Sykes Bros. have completed a preliminary survey for a railway in the suburbs.

Allentown, Pa.—The Town Council has granted permission to the Allentown Passenger Ry. to operate its road by the single trolley system. The change will be made as soon as possible.

McKeesport, Pa.—Local parties have projected a road from Christy Park through the center of this town to Riverton, a distance of 4 miles.

Baltimore, Md.—The council committee on city railways has decided to report favorably the ordinance granting the North Avenue Ry. Co. power to extend its lines over several streets.

Atlanta, Ga.—F. Carter, Secretary of the Capital Ry. Co., will receive bids for constructing a 5-mile single-track overhead electric railway. The Atlanta Street Ry. and the Atlanta & Edgewood Street R. R. have been bought by A. A. Glasier for New York and Boston parties. Twenty-one miles of road were transferred. The new owners will use electricity exclusively, it is said, and lay double tracks wherever practicable.

Little Rock, Ark.—The Capital Street Ry. Co. has bought land for its new power plant. The company operates 17 miles of road, all of which will receive electrical equipment.

Denver, Col.—The Denver Tramway Co. has decided to abandon their cable on 18th st. and use electric cars. The Denver, Lakewood & Golden Ry. has let a part of the contracts for a branch to Arvada.

Tacoma, Wash.—The Tacoma Railway & Motor Co., controlling nearly all the desirable streets in the city, has negotiated a $70,000 loan and will immediately resume work on its principal lines.

Elevated Railways.—***Boston, Mass.***—Leave to withdraw, with the consent of the petitioners, was reported unanimously by the street railway committee of the legislature on the petitions for authority to construct elevated roads in this city. The petitioners were R. T. White, W. B. Mack, F. A. Bartholomew and others.

Brooklyn, N. Y.—The directors of the Brooklyn Elevated R. R. have decided to remove about three-quarters of a mile of elevated structure that has been recently paralleled by a line only one block away. There is some talk of using the material in the proposed Cypress Ave. extension, but as it is all old this will probably not be done.

Horse Railways.—New lines are reported as probable in the following places: Hampton, Va.; Charleston, S. C., address the National Land & Improvement Co.; Wilkerville, Mich.; Pueblo, Col.

Hampton, Va.—The Hampton & Old Point Ry. Co. has received permission from Congress to lay tracks through the government reservation.

Murfreesboro, Tenn.—The franchise and plant of the Murfreesboro Street R.R. is for sale.

Lumber Railway.—***Salem, Ore.***—A 25-mile pole road is under discussion. It will probably be built, if at all, by Portland parties.

Cable Railway.—***Washington, D. C.***—The Washington & Georgetown R. R. has awarded a contract to the Smith & Vaile Co., of Dayton, O., for $150,000 of castings. The boilers in the new plant will consume so much water that the existing city mains will be insufficient to furnish the amount, and a special supply main will probably be laid to the river.

San Francisco, Cal.—Contracts for extensions of the Belt R. R. along the water front will be soon advertised. Engineer Manson has completed the plans.

Dummy Railway.—*St. Charles, Mo.*—J. S. Gordon, of St. Louis, has applied to the City Council for a dummy road franchise.

New Companies.—Electric Freight Railway, Fall River, Mass.; capital stock, $500 000; incorporators, E. A. Benson, W. H. Crary, J. B. Carmichael and others. Spokane University Heights Street Ry., Spokane Falls, Wash.; capital stock, $100,000; incorporators, A. Garrett, R. Abernethey, L. B. Cornell. Cottage City, Mass., Street Ry. Co.; capital stock, $15,000; E. G. Eldridge, President. U. S. Street Car Motor Mfg. Co., Chicago, Ill.; capital stock, $3 0,000; incorporators, W. B. Cunningham, C. G. Vogel, H. H. Kennedy. Central Ave. Ry. Co., Oakland, Cal.; capital stock, $1,000,000; incorporators, M. H. Grossmayer, W. F. Beck and others. Detroit & Dearborn Street Ry. Co., Detroit, Mich.; capital stock, $100,000. Davy Electric Suspension Co., Chicago, Ill.; capital stock, $10,000,000; incorporators, G. W. Cole, J. W. Davy, W. W. Shrader, L. W. Bryan. Riverside, O., Electric Street Ry. Co.; capital stock, $50,000.

HIGHWAYS.

New York.—The stockholders of the Jericho Turnpike have voted to surrender their road to the towns of Oyster Bay, North Hempstead, Hempstead, Flushing and Jamaica (Long Island). The road runs from Jericho, in the town of Oyster Bay, to Queens, in the town of Jamaica. The Town Board of North Hempstead will be requested to present a resolution, to be voted upon at the town meeting in April, asking for an appropriation of $65,000 to macadamize the North Hempstead portion of the road. The north turnpike in North Hempstead, from Little Neck to Roslyn, is now under contract, and will be completed this summer.

New Jersey.—Governor Abbett has approved the bill which authorizes township committees to have full supervision of all roads and to appoint a person to have charge of them. This makes null and void the election of road overseers in the various townships of the state. Under the law the township roads were cared for by overseers elected by the people in the different road districts of each township. These men were often incompetent, and the farmers on the road were allowed to work out their road tax. In consequence of this the roads were in bad condition. The bill is approved by the State Board of Agriculture.

Pennsylvania.—At a meeting of the farmers of southern Chester Co. at Kennett Square, on March 12, to consider the road bills now before the legislature, a resolution was passed indorsing the present road law, but recommending that 25% of the tax be laid aside for permanent improvements in connection with the state appropriation. The Franklin Co. farmers claim that the demand for road improvements comes from the people of towns and cities, and that these people should pay some of the cost of the improvements.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*St. Johnsbury, Vt.*—There is talk of constructing a bridge across the Passumpsic River, to cost $50,000.

Huntington, Ind.—Bids will be received for the construction of a bridge 200 ft. long at this place. Estimated cost, $25,000.

Flowerton, Ala.—A bridge will be built across the Big Escambia River near this place.

Shawnee Co., Kan.—The following bridgework will be done in this county the present season:

On section line, between sections 5 and 8, township 10, range 15, Menoken township; estimated cost, $800. On Rowles road, two miles west of Auburn, in Auburn township; estimated cost, $800. On north line of near quarter, section 14, township 12, range 15, Topeka township; estimated cost, $500. On Twenty-first St., Topeka township; estimated cost, $400. On Kansas Ave. road, in section 7, township 12, range 16, Topeka township; estimated cost, $300. On Kansas Ave. road, in section 7, township 12, range 16, Topeka township; estimated cost, $300.

WATER-WORKS.

NEW ENGLAND.

Boothbay, Me.—An act to incorporate the Boothbay & Boothbay Harbor Water Co. has been passed.

Millbridge, Me.—Works are under discussion. There is talk of bringing a supply from Round Pond, 6 miles distant.

Exeter, N. H.—Elbert Wheeler, Secretary, 24 Washington St., Boston, has sent the following:

The company has not yet made definite plans regarding the proposed extensions through the towns of Stratham and South Newmarket, but has simply sought to obtain the necessary legislative authority therefor.

Rutland, Vt.—At the village election March 25 the people will vote on the question of constructing a new dam and settling reservoir for an additional supply, a new supply main and reservoir. J. W. Burke is making surveys for the proposed new supply.

Salem, N. H.—The Salem Water Works Co. has been incorporated by Senator Frank P. Woodbury, O. E. Branch, G. E. Hodgon and others to supply water in Salem and Salem Depot and elsewhere. It is believed that the "and elsewhere" is intended to give the company power to supply water to Massachusetts cities, notably to Lawrence and Lowell. The capital stock of the company is limited to $1 0,000. As the act only provides for condemnation proceedings in Rochester Co. the company's supply could be drawn from this county only.

Nashua, N. H.—The Pennichuck Water Co. is to remodel its upper pumping station, add a 43-in. Risdon turbine, and a 3,000,000 gall. Gaskill pumping engine to work against a pressure of 150 lbs. to the square inch. The turbine is on the ground, and the pump has been contracted for.

Braintree, Mass.—The suit of the Braintree Water Supply Co. against the town to oblige the latter to buy the company's works, in accordance with a vote taken Jan. 12, 1887, but afterwards rescinded, has finally resulted in favor of the company. The town is to pay $159,610 for the works. The case has been in the courts for a long time.

Gloucester, Mass.—The purchase of the company's works by the town is still under consideration.

Hamilton, Mass.—At the recent annual town meeting the water works question was indefinitely postponed.

Lowell, Mass.—Prof. W. T. Sedgwick has reported to the water board that evidences of pollution to the Merrimac River water supply are conclusive. See note under Salem N. H., regarding project for new supply.

Methuen, Mass.—J. S. Howe, Town Clerk, informs us that the town has voted to ask the legislature for authority to build works, but it is doubtful whether definite plans for works are made this year.

Newburyport, Mass.—C. H. De Rochement, J. J. Putnam and others constitute a committee on water supply which is now investigating the purchase of the company's works.

Waltham, Mass.—The aldermen have ordered the expenditure of $20,000 for water-works extensions.

Newport, R. I.—A new 4,500,000-gall. pump has arrived for the Newport Water-Works Co.

Bethel, Conn.—At a special meeting of the borough the people authorized the Water Commissioners to award contracts for the proposed filter bed and dam. Bids have already been received ranging from $5 500 to $11,000. It is probable that Engineer W. B. Rider's bid of $6,323, including plans and superintendence, will be accepted. The filter was described and illustrated in our issue of March 7.

MIDDLE.

Albany, N. Y.—The Special Water Commission has reported in favor of a new supply of 15,000,000 galls. a day from the Normanskill, including a dam above French's Mill, to form a storage reservoir, with an area of 600 acres, and an available capacity of 1,955,000,000 galls.; also a 48-in. cast iron supply main. An offer to construct the works necessary for the new supply has already been made, the price being $900,000, including $225,000 for right of way. The report is given in considerable detail in the Albany *Journal* for March 16.

Brooklyn, N. Y.—It is reported that Commissioner of City Works J. P. Adams will soon invite bids for the proposed water tower. The tower was described and illustrated in our issue of Feb. 7. There will be a wrought iron stand-pipe 16 × 75 ft., inclosed in a masonry tower, the whole located on the embankment of the Mt. Prospect reservoir, within the city.

Mechanicsville, N. Y.—It is reported that the village board is quietly investigating the introduction of works.

Northville, N. Y.—The contracts for works have been awarded as follows: Pipe, C. Millar & Son, Utica; hydrants, Ludlow Manufacturing Co., Troy; valves and boxes, Rensselaer Manufacturing Co.; pipe-laying and reservoir, D. Sullivan, Flushing. The total of the various contract prices is $27,000.

Pelham Manor, N. Y.—The following is from Fogg & Scribner, Contractors for the works, 1441 Broadway, New York:

The Pelham Heights Water Co. has let the contract for works to the above firm, and construction has been started. J. T. Fairchild, Mt. Vernon, is Engineer, and should be addressed for further information. There will be about 8 miles of pipe. The supply will be either from the gravity works at New Rochelle or from the stand-pipe of the Mt. Vernon works.

Rochester, N. Y.—An act enabling the city to issue bonds for a new conduit is under consideration. It provides for $1,750,000 of 3½, 50-year bonds. Also for the appointment by the Common Council of an additional Water Supply Commission of three members.

Camden, N. J.—The Senate has passed an act authorizing the issuance of bonds for a new water supply.

Collingswood, N. J.—The Collingswood Water & Light Co. has been incorporated; capital, $25,000.

Plainfield, N. J.—The authorities caused Dowd & Rice, Contractors for the Plainfield Water Supply Co., noted last week, to stop work as soon as they began trenching for distributing mains. The company was beginning operations under a charter granted 22 years ago, before the city was incorporated, and has no authority from the city to dig up the streets. The case will go into the courts.

Bridgeport, Pa.—Construction of the works was started March 16.

Carbondale, Pa.—Incorporations are reported of both the Clinton and Fell Water companies, each with a capital of $2,000. The latter was inadvertently noted last week under Fell.

Yorkville, Pa. (Pottsville, P. O.)—The borough proposes to obtain a supply from the Minersville Water Co., of Minersville. It is estimated that the extension of the company's mains to the Yorkville will cost $15,000, this cost to be met by the borough. It is reported that the company has consented to supply the borough.

Washington, D. C.—Henry Hart, President of the Washington & Georgetown [Cable] Ry. Co., has asked for permission to lay a 12-in. main from the tidal reservoir to supply his company's engines, on the ground that the city cannot furnish a sufficient amount of water. The authorities admit that it is not practicable to supply from the distributing mains the water needed, but think they have no power to grant an individual or company the right to lay mains in the streets.

SOUTHERN.

Abingdon, Va.—The company has contracted for additional pumping machinery.

Front Royal, Va.—The Front Royal & Riverton Improvement Co. is projected to build works.

Shenandoah, Va.—The Shenandoah Land & Improvement Co. has received the contract for works.

Keyser, W. Va.—A bill authorizing the issuance of bonds for water-works and other improvements has passed the senate.

Wheeler, W. Va.—Improvements are under consideration.

Hickory, N. C.—Bonds for works have been voted by the people. G. N. Whitener is mayor.

Columbia, S. C.—W. H. Gibbs, Jr., & Co., Columbia, have been awarded the contract for parts of the new works. New bids will be asked for breakwater and stand-pipe. A Worthington pump and Victor turbine will be used.

Darlington, S. C.—The following is from G. M. Boyd, Secretary of the former water company:

The Darlington Water Works Co. was organized last summer, but did not finish works. It recently sold out to the Darlington Light, Water & Power Co., of which W. F. Dargan is President. Population, 3,500.

Greenville, S. C.—It is reported that works will be built by the Paris Mountain Land & Improvement Co.

Newberry, S. C.—J. K. P. Goggans, Mayor, informs us that a citizens' meeting was held Thursday evening to hear and act upon the report of a committe on new water-works and electric lighting plants.

Macon, Ga.—A. E. Boardman is President, W. A. Jeter, Vice-President and J. B. Hall, Secretary of the reorganized company here.

Columbia, Ala.—The following is from R. H. Gray, Clerk:

The town has sunk an artesian well and the legislature has authorized bonds for works. The town intends to build works in the future, but the time is indefinite. Population, about 1,200.

Opelika, Ala.—A franchise has been granted to the American Pipe Co.

Clarksdale, Miss.—The Clarksdale Water, Light & Power Co. has been incorporated; capital, $100.000.

Yazoo City, Miss.—The Yazoo Improvement Co. has been incorporated to construct water-works, electric lighting and heating plants; capital, $100,000.

Cleveland, Tenn.—The following is from J. H. Hardwick:

An investigating committee has reported in favor of granting a franchise to Sturtevant & Co., but the matter must be decided by a popular vote. A majority of the citizens are in favor of city ownership, and in case the present proposition fails a vote will be taken to decide whether the city shall build the works. It is proposed to pump from springs to a stand-pipe. Estimated cost, $3,500. Population, 4,000.

It is reported that a bill authorizing the town to issue bonds for works has been introduced in the legislature.

Dayton, Tenn.—J. M. Hamerd, Mayor, informs us that a franchise has been granted to George J. Morris, Boston, Mass., but that no definite steps towards construction have yet been taken.

Nashville, Tenn.—Water-works bonds to the amount of $310,000 may be issued.

Hickman, Ky.—The people have voted to issue $20,000 of bonds for works.

Mayfield, Ky.—Address B. A. Neale regarding proposed works.

Stanford, Ky.—The Stanford Water-Works Co. has been incorporated; capital, $75,000.

NORTH CENTRAL.

Cincinnati, O.—A bill is before the legislature providing for four water-works trustees and authorizing them to borrow $5,000,000 for an additional water supply.

Greenfield, O.—The following is from G. W. Milholland:

The village proposes to issue bonds for works to cost from $35,000 to $40,000, pumping from Paint Creek to a stand-pipe. H. L. Dickey is Chairman of the water committee, Frank Smith, Xenia, is Engineer, and if the people vote to build works John P. Martin, also of Xenia, will be the contractor. Population, 2 80).

Toledo, O.—Specifications for new pumping machinery will soon be ready.

Noblesville, Ind.—A vote in favor of works has been taken.

Holland, Mich.—John Kramer, Superintendent, informs us that a vote will be taken April 2 on water-works

improvements. The city expects to spend about $17,000 for mains and hydrants.

Muskegon, Mich.—It is reported that the water supply is inadequate.

Collingsville, Ill.—Works are projected. J. R. Wadsworth is Secretary of the water-works investigating committee.

Danforth, Ill.—John Overacker has sent the following:

The village proposes to build works costing about $2,700. The supply will be pumped from existing artesian wells to a tank. The U. S. Windmill Co. are Engineers, and will probably be Contractors. Population, about 400.

Dundee, Ill.—The following is from J. G. Frick, City Clerk:

Water-works in this place depends largely upon the officials elected at the coming annual meeting. The proposed supply is from Fox River, and the estimated cost of works is $15,000 to $20,000. Population, 2,000.

Oak Park, Ill.—E. W. Lyman, President of the Board of Trustees of the town of Cicero, informs us that the town expects to obtain water from Chicago to supply several villages within its limits. Oak Park has been supplied since 1885 by a company.

Peru, Ill.—On Nov. 31 a special election will be held to vote on $22,000 of bonds for new works.

NORTHWESTERN.

Avoca, Ia.—The following is from A. W. Candless, Town Recorder:

The town will build works at a cost of about $13,000. The supply will be pumped from wells to a stand-pipe. Contracts were to have been let March 16. G Diederich is Chairman of the water committee, and J. J. Hipsley, Mayor. Population, 2,000.

Albert Lea, Minn.—Plans for work are being prepared by W. W. Curtis, St. Paul. Water will be pumped from an artesian well to a 100,000-gall. iron tank placed on an iron tower. About 2,000 ft. of 10-in pipe will be laid this season. No contracts have been let. Estimated cost, $18,000. Population, about 4,500.

Chatfield, Minn.—Bonds for works have been proposed.

Madelia, Minn.—It is reported that the issuance of bonds for works is under consideration.

Renville, Minn.—It is reported that $10,000 of 7% water bonds have been proposed.

Windom, Minn.—Bonds to the amount of $25,000 are proposed for water-works.

Willmar, Minn.—The following is from H. J. Ramsett Recorder:

The town will let contracts March 27 for works. The supply will be pumped from a deep well to a tank., Estimated cost, $20,000. Robert Edder, St. Paul, Minn., is Engineer.

Auburn, Neb.—The following is from E. A. Rudiger, Engineer, Nebraska City:

Surveys and estimates for works have been made and a vote on the issuance of bonds will be taken at the April election. The town is so scattering that it will be difficult to put in a small system that will give general satisfaction. Water will probably be pumped from wells to a tank with about 1¾ miles of 4 and 6-in. mains and 15 to 20 hydrants; estimated cost, $12,000. Population, 1,800.

Beatrice, Neb.—O. V. P. Stout, City Engineer, informs us that there is a bill before the legislature authorizing a new supply of water. Bids are asked for sinking a test well 5 ft. in diameter.

Blair, Neb.—A vote will be taken April 7 on bonding the town for water works extensions.

Laramie, Wyo.—Citizens have petitioned the council to submit to the people at the next election the question of issuing $100,000 of bonds for a new supply.

SOUTHWESTERN.

Kansas City, Mo.—An ordinance has passed both branches of the Council providing for the issuance of $2,000,000 of bonds for the construction of works by the city. A popular vote must be taken to authorize the bond issue. In a letter written March 6 Mayor Benjamin Holmes stated: "There is no probability that this city will begin the construction of water-works in the near future."

Denton, Tex.—The Denton Water, Light & Power Co. has been incorporated; capital, $50,000.

Hartley, Tex.—A contract for constructing works has been awarded to C. E. Hartley.

Sulphur Springs, Tex.—Bids for water works, sewerage and electric lights are wanted until April 1. Population, 3,500. W. F. Henderson is Mayor.

Waxahachie, Tex.—The Waxahachie Improvement & Water Co. has been incorporated; capital, $30,000. It is reported that construction will be started within 30 days.

Yoakum, Tex.—The Yoakum Artesian Well & Water Co. is proposed; capital $2,000.

Harman, Col.—The people voted, 48 to 35, to contract with the Denver Water Co. for a supply. There will be 20 hydrants at $35 per annum for the first and $25 for the second 10 years.

PACIFIC.

Ocosta, Wash.—The following is from F. M. Rummell:

The Ocosta Land Co. and the Northern Pacific R. R. Co. propose to put in a water tank here. The supply will be from springs, and it is intended to furnish water for domestic use and fire protection. The village is but 10 months old and has a population of 300.

Snohomish, Wash.—Agitation for a better water supply continues. Several parties have submitted propositions.

Salem, Ore.—The Salem Water Co. has begun the extension of its mains to South Salem. A 2,000,000-gall. reservoir will be built. The improvements will cost about $50,000.

San Jose, Cal.—The following is from S. N. Rucker, Mayor:

The Glen Weber Water Co. has asked for a franchise and made a proposition to sell a permanent water right to the city. No action has been taken in the matter, and I do not know that any will be taken.

The city has been supplied since 1865 by the San Jose Water Co.

CANADA.

Toronto, Ont.—The water-works committee of the aldermen recently voted to make another effort to secure two new 10,000,000 gall. pumps, and adopted a resolution asking for $120,000 for this purpose and for a new pumping station.

ARTESIAN WELLS.

Valdosta, Ga.—The mayor and council have decided to sink an artesian well at once.

Greensboro, Ala.—A well with 6-in. casing is being sunk.

Amite City, La.—It is reported that a well will be sunk.

Mellette, S. Dak.—It is reported that the first well sunk in Spink Co. wholly for irrigating purposes has been completed on J. W. Baker's farm, 5 miles south of Mellette. It is said that the well is 920 ft. deep, and has an estimated flow of 2,000 galls. per minute.

Hallettsville, Tex.—A 6-in. casing is being substituted for a 1½-in. casing in a small well here. It is reported that another well will be sunk and the two will supply the water-works now being built.

Yakimia County, Wash.—A bill has passed the House authorizing the county to appropriate $2,500 to carry forward work on a well in the Horse Heaven Country. The sum of $4,000 has been appropiated previously and the well is now down 550 ft.

IRRIGATION.

Culbertson, Neb.—The Culbertson Irrigation & Water Power Co. has been incorporated; capital, $20,000.

Hoehne, Col.—The Texas Ditch Co. has been incorporated; capital, $6,000.

Albuquerque, N. M.—According to the Denver *Republican*, the Rio Grande Irrigation & Colonization Co., composed of Boston capitalists, proposes to construct works and irrigate land in the Rio Grande valley, New Mexico. It is said that the company has been authorized to construct works on both sides the river from Pena Blanca to the Texas line, and that part of the scheme is to improve, colonize and sell the land reclaimed.

Oregon.—The following irrigating companies have recently been incorporated:

At Chewaucan Valley, Lake Co., the Bagley Irrigating Ditch Co., by I. J. Harris, R. W. Phillips and others, with a capital of $3,750. At Lakeview: The Twenty-Mile Irrigation Co., by W. J. Moss, J. S. Field and Peter Post, with a capital of $3,000; the Cogswell Creek Water Co., by S. J. Studley and others, with a capital of $1,000. At Prineville, the Swartz Cañon Irrigation Co., by J. W. Howard and others, with a capital of $5,000.

SEWERAGE AND MUNICIPAL.

Sewers.—*Nantucket, Mass.*—A committee has been appointed to investigate the question of introducing a system of sewerage.

Boston, Mass.—Work has been commenced on the Charles River sewer from Watertown to Waltham, about 4 miles. It will be 4 ft. diameter. The Water Board has asked for authority to make a contract with the town of Westboro for the removal of the sewage of that town outside the watershed of the Sudbury River, at a cost not exceeding $20 000, the sum to be charged to the appropriation for additional water supply.

Taunton, Mass.—It is proposed to issue sewer bonds for $200,000.

Pawtucket, R. I.—A main sewer is being built to drain the settled portion of the ridge separating the Moshassuck from the Blackstone and Seekonk rivers. The sewage will be discharged by gravitation upon filter beds. Eventually a system of pumping must be used to raise the water from the low and west districts onto the beds.

Albany, N. Y.—The West End people want the Beaver Creek sewer built under a bonding act of 5 or 10 years.

Englewood, N. J.—The town has accepted the offer of Mr. Phelps to pay half the cost of dredging the canal which takes the surface drainage, and has appropriated $2,000 for the work.

Baltimore, Md.—The headings of the Cross St. sewer tunnel have met. The tunnel will be 1,065 ft. long and 5 ft. diameter. It will be lined with brick.

Manchester, Va.—Numerous proposals have been received for constructing the sewers. A consulting engineer is to be engaged.

Wilmington, N. C.—The new sewers are to discharge at the wharves along the river.

Indianapolis, Ind.—It is proposed to convert the State ditch into a main sewer for the northeast portion of the city. Mr. C. B. Fletcher has prepared for the Commercial Club an extensive report upon the condition of the sewer system.

Waukegan, Ill.—Mr. J. A. Cole recommends a system of sewerage discharging into the ravine through the city. A report upon and plans for the proposed system will cost $500.

Rogers Park, Ill.—The village is constructing an extensive system of sewers, paid for by special assessments. Mr. Geo. H. Simpson is the engineer in charge.

Manitowoc, Wis.—It is proposed to issue sewer bonds for $10,000.

Seattle, Wash.—A system of sewerage is being advocated, its need becoming increasingly evident with the growth of the city.

Beaumont, Tex.—A bill is before the legislature to authorize the issue of bonds for sewer purposes. Mr. Lee Daniell will be in charge of the work.

Streets.—*Hartford, Conn.*—It is proposed to pave Main St. with asphalt at a cost of $25,000.

Pittsburg, Pa.—The Supreme Court has decided that the street acts of 1889, under which the city has been operating, are constitutional. Two bills are to be presented to provide for a reassessment for public improvements under way, and for assessments for street improvements and sewers.

Washington, D. C.—Capt. Rossell, the engineer in charge of street improvements, intends to begin work shortly on the improvement of the suburban streets. The work will include grading, macadamizing and paving with granite blocks and asphalt.

Savannah, Ga.—East Broad St. is to be paved with granite blocks, and Bull St. with granite blocks or sheet asphalt.

Mobile, Ala.—Dauphin and Commerce Sts. are to be paved with round wooden blocks.

Lancaster, O.—The City Council has provided for a considerable amount of brick paving and new sewers.

Terre Haute, Ind.—The City Council is considering the street paving question, and the city engineer has been collecting information from cities using brick paving.

Kansas City, Mo.—Some alleys are to be paved with Kansas City vitrified brick, laid on edge, on a concrete foundation 6 ins. thick.

St. Louis, Mo.—The Street Commissioner has completed plans for ashphalt paving on streets in a certain district of the city.

Omaha, Neb.—The Board of Public Works is revising the specifications for street work.

Salt Lake City, Utah.—It has been decided to try brick paving for streets.

San Francisco, Cal.—The Street Committee has decided that redstone is not to be used in concrete foundations for streets. The foundation must be left for 7 days before the bituminous rock pavement is laid, which pavement must be 3 ins. thick.

Municipal Government.—*Allegheny, Pa.*—An ordinance has been passed establishing city departments, including a Department of Public Works, which will have charge of streets, sewers, water-works, lighting, etc. In this department will be bureaus of engineering and surveys, public lighting, highways and sewers, water supply, etc.

Cleveland, O.—Under the new form of government recently adopted all boards are abolished, and each department is now to be conducted by one man, directly responsible to the mayor. The public improvements will be under the Director of Public Works.

Garbage Disposal.—A committee of the American Public Health Association is visiting a number of cities to investigate the different methods of garbage disposal. A garbage cremator has been established at Chicago, Ill. The cremator is 35 × 14 ft. and 17 ft. high, with 4 chambers, and has a capacity of 120 tons per day. The fuel is petroleum, sprayed in by steam jets. A garbage cremator is proposed at Americus, Ga., at a cost of $3,000 to $5,000.

Drainage.—It is reported that the most extensive system of drainage yet undertaken in the lowlands of Central Illinois, is now being planned in Arcola, Tuscola, Garrett and Bourbon by the drainage commissioners. Garrett has already let the contract for a canal 3 miles long at a cost of about $25,000, and Tuscola advertised for bids for the construction of a drainage canal 6 miles long and 40 ft. wide, to cost about $100,000, and for another 3 miles long. Arcola also is about to let a contract for the construction of a canal 3 miles long. The work is to be done by steam dredges, and is very expensive to the land owners, who complain of the increased taxation.

ELECTRICAL.

Electric Light.—New plants or extensions of those already existing are reported as probable in the following places: Milford, Mass.; South Manchester, Conn., address the Village Improvement Society; Stanton, Mich.; Ithaca, Mich., address W. T. Benalack; Santa Cruz, Cal., address O. J. Lincoln; Hingham, Mass.; Elkin, N. C., address H. T. Brown; Fort Dodge, Ia.; South New Market, N. H.; Keesville, N. Y.; Stanford, Ky., address the Stanford Water-Works; Greenwood, Miss., address the Ragsdale Mfg. Co.; Navasota, Tex., address E.L. Bridges; Basic City, Va.

Richmond, Va.—Although the bill appropriating $75,000 for an electric light plant has been rejected by the

Board of Aldermen, the matter is by no means dead, as the people are apparently in favor of the measure.

Augusta, Ga.—Mayor R. H. May wishes information and prices for a municipal lighting station.

Vicksburg, Miss.—The Hill City Electric Light Co. will it is said, issue $20,000 of bonds for improving its plant.

Chehalis, Wash.—At a special meeting of the City Council it was decided to purchase an electric plant for the city without delay.

New Companies.—Kane, Pa., Electric Light Co.; capital stock, $5,000; S. H. Brownlee, Manager. Carondelet, Mo., Electric Light & Power Co.; capital stock, $100,000; F. W. Mott, Secretary. Bowling Green, Mo., Electric Co.; capital stock, $6,000; Dr. B. A. Wilkes, Secretary. Jenkinton, Pa., Light Co.; capital stock, $100,000; L. R. Shulz, Secretary. Marquette Heating & Light Co., La Salle, Ill.; capital stock, $4,500; incorporators, W. E. Birkenburl, J. E. Malone, N. Strauss and others. La Grange, Ky., Electric Light & Power Co., capital stock, $15,000; D. C. McDowell, Secretary. Bellevue, O., Light & Power Co; capital stock, $20,000; incorporators, P. Brady, J. H. Weber, J. A. Wright and others. Denver Highlands, Colo., Electric Co.; capital stock, $500,000; incorporators, H. S. McDowell, R. H. Porter and R. E. Clark. Aluminum Carbon Co., Lancaster, N. Y; capital stock, $40,000; F. V. Doty, Secretary. Pocatonia, Ill., Electric Light & Power Co.; capital stock, $10,000; incorporators, J. W. Wolvin, F. L. Colby, B. A. Knight. H. A. Doty Light & Power Co., Janesville, Wis.; capital stock, $30,000; incorporators, H. A., M. E. and E. P. Doty. Western Electric Storage Battery Co., Kansas City, Kan.; capital stock, $500,000; incorporators, N. McAlpine, W. B. Stone, A. A. Lovelace and others. Incandescent Light & Power Co., Norwalk, O.; capital stock, $25,000.

CONTRACTING.

City Work.—*Duluth, Minn.*—Contracts have been awarded by the Board of Public Works for a considerable amount of street and sewer work. Mr. Miron Bunnell is President of the Board; Mr. W. B. Fuller is City Engineer. The contract prices average as follows:

Earth excavation, grading	25 to 38 cts. per cu. yd
Rock " "	$1 to $1.80 "
Earth " foundations	30 to 70 cts. "
Rock " "	$4 to $4.50 "
Borrow	38 to 55 cts. "
Gravel and rolling	95 cts. "
Loam	50 to 80 cts. "
Timber	$18 to $22 per M. B. M.
Rough stone gutters	85 cts to $1.10 per sq. yd.
Masonry, mortar rubble	$4 to $5 per cu. yd.
Masonry, dry rubble	$3 "
Masonry, cut stone	$21 to $25 "
Pene hammered work	20 to 30 cts. per sq. ft.
Telford paving	$1.10 per sq. yd.
Cedar block paving	$1.05 "
Rip rap	$1.60 per cu. yd.
Paving in mortar	$1.25 to $2 per sq. yd.
Rough stone paving	65 to 75 cts. "
Crushed stone	$2.30 to $2.75 per cu. yd.
Gas tar	10 to 13 cts. per gall.
Sewer brick	$17 to $20 per 1,000
24-in. rubble sewer	$1.60 per lin. ft.
21 and 24 in. pipe in concrete	$2 and $3 " "
15-in. pipe in sand	55 to 90 cts. " "
12-in. " "	40 to 55 cts. " "
44-in. concrete sewer	$4 30 " "
6-in. inlet pipe in sand	25 to 29 cts. " "
8-in. " " "	26 to 37 cts. " "
9 in. " " "	29 to 43 cts. " "
12-in. " " "	40 to 60 cts. " "
15-in. " " "	55 cts. " "
Brick sewer, 22 × 33 ins.	$2.25 " "
" " 26 × 39 ins.	$3 to $4.75 " "
" " 28 × 42 ins.	$3.25 " "
Wrought iron pipe ¾-in	20 cts. " "
Automatic flush tanks	$100 to $110 each.
Manholes	$50 to $55 "
Special manholes	$160 "
Catch basins	$75 "
Intakes	$35 to $45 "
Castings	4 cts. per lb.

Street Work.—*Detroit, Mich.*—Contracts have been awarded as follows for cedar block paving: J. A. Stewart, $1.81 with Berea curbing, or $1.88 with Medina stone curbing; H. Meridan, $1.72½ and $1.78 for similar work; J. A. Cook, $1.76¼ to $1.79¾ for Berea and $1.78¼ to $1.81¾ for Medina.

Street Cleaning.—*Albany, N. Y.*—The Board of Contract has awarded contracts for removing street dirt as follows: John Kelly, 1st, 2d and 3d districts, 50, 40 and 40 cts. per load. Ezra Bush, 4th and 5th districts, 47 and 43 cts. per load.

Dredging.—The following proposals have been received by Col. D. C. Houston, U. S. Engineer Office, New York City: For 50,000 cu yds. in Mystic River, Conn., Hartford Dredging Co., Hartford, Conn., 14.7 cts. per cu. yd; E. M. Payn, Albany, N. Y., 14.9 cts.; C. M. Cole, Fall River, Mass, 17¾ cts.; Elijah Brainard, New York, 18 cts.; C. & H. E. DuBois, New York, 20 cts. For 140,000 cu. yds. in New Haven harbor, Conn.; C. & H. E. DuBois, 9.9 cts. per cu. yd.; Thos. Potter, Jersey City, N. J., 12⅜ cts.; Geo. B. Beardsley, Bridgeport, Conn., 13½ cts. For 100,000 cu. yds. in Thames River, Conn.; Elijah Brainard 24.5 cts. per cu. yd.; Hartford Dredging Co., 27 cts.

The following proposals for dredging in Mackey's Creek, N. C., were opened March 11 by Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C.: Alabama Dredging & Jetty Co., Mobile, Ala., 26 cts. per cu. yd. in scow; Chester T. Caler, Norfolk, Va., 29.5 cts. in scow or 34.5 cts. in situ (34.5 cts. in situ equals 27.5 cts. in scows according to the specifications); P. Sanford Ross, Jersey City, N. J., 49 cts. in scow.

The following proposals for dredging 16,000 cu. yds. in the Napa River have been received by Major Benyaurd, U. S. Engineer Office, San Francisco, Cal.: J. C. Smith, 50, 60 and 70 cts. per cu. yd.; T. H. Williams, 46 cts.; San Francisco Bridge Co., 59 cts.; Pacific Coast Dredging Co., 60 cts.

Harbor Work.—*Philadelphia, Pa.*—The War Department has desided to reject the 3 bids received from the Pennsylvania, National and American dredging companies for removing the islands in Philadelphia harbor, and to prepare new specifications for the work. Proposals will be received until April 10.

Stone.—*Oakland, Cal.*—The following proposals for furnishing 11,000 tons of stone and laying 5,000 ft. in Oakland harbor, have been received by Col. Mendel, U. S. Engineer Office, San Francisco, Cal.: San Francisco Bridge Co., $1.49 per ton, 14 cts. per ft.; Geo. Stone, $1.52, 11½ cts.; Randall Hunt, $1.58, 13½ cts.; John Dare, $1.60, 12 cts.

Levees.—The Board of Levee Commissioners, New Orleans, La., has awarded contracts as follows: Section No. 1, Jeffries & Dameron, 17¾ cts. per cu. yd.; Section No. 2, 18 cts.; Section No. 3, Jeffries & Dameron, 28½ cts.; Section No. 4, James Cotten, 23 cts.; Sections Nos. 5 and 6, J. Scott & Son, 23 and 19½ cts.; Section No. 8, Anderson & Ogden, 17¾ cts.; Section No. 10, Martin Jennings, 19½ cts.; Section No. 10, S. D. Moody, 19 cts. The Board of Commissioners of the Fifth Louisiana Levee District has awarded contracts as follows: Bunches Bend levee, Ernest Hyner, 19 cts.; Point Lookout levee, J. W. Crump, 18¾ cts.; Henderson and Mascot levee, J. Stein & Co., 20 cts.

PROPOSALS OPEN.

Stone.—*Montgomery, Ala.*—About 600,000 granite paving blocks. J. G. Crommelin, Chairman of Street Committee. April 1.

Louisville, Ky.—For wall of basin on Louisville & Portland Canal. Capt. E. Maguire, U. S. Engineer Office, April 11.

Street Work.—*Kearny, N. J.*—Grading, curbing, guttering and flagging. J. Randall, Township Clerk. March 24.

Cleveland, O.—Medina block stone paving. C. G. Force, City Engineer. March 26

Beatrice, Neb.—Brick paving and stone curbing. O. V. P. Stout, City Engineer. March 26.

New York, N. Y.—Granite block paving on concrete, 34 contracts; 1 contract for trap rock surfacing. Departpartment of Public Works, 31 Chambers St. March 30.

Montgomery, Ala.—Granite block paving on Commerce St. and Court Sq. J. G. Crommelin, Chairman of Street Committee. April 1.

Sewers.—*Newark, N. J.*—Salt-glazed sewer pipe, 12, 15 and 18-in.; manholes and basins. John Hunkele, Street Commissioner. March 23.

Cleveland, O.—C. G. Force, City Engineer. March 26 and April 2.

Middletown, O.—Brick and tile sewer. B. J. Niederlander, City Clerk. April 4.

Pipe and Castings.—*Washington, D. C.*—Cast-iron water pipe, 6, 12, 16 and 20-in.; special castings and valves. The District Commissioners. March 31.

Highway.—*Auburn, Me.*—About 8,000 ft.; 6,000 cu. yds. earth or loam and 22,000 cu. yds. earth and rock excavation, 18,000 sq. yds. macadamizing. Aspinwall & Lincoln, 12 Pearl St., Boston, Mass. March 28.

Wall.—*Boston, Mass.*—Retaining wall on Ferdinand St. Wm. Jackson, City Engineer. March 28.

Gas Lighting.—*Belem, Para, U. S. of Brazil.*—Brazilian Consulate General, 6 Great Winchester St., London, England. July 19.

Dredging.—*New York, N. Y.*—About 3,500 cu. yds. in the North River and 4,200 cu. yds. in the East River. Department of Docks, Pier A, North river. March 27.

Bridge.—*Minneapolis, Minn.*—Superstructure of viaduct carrying a street across the Minneapolis & St. Louis Ry. Engineer, C. F. Loweth, St. Paul, Minn. March 25.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., have sent 2 engines to the Chicago & Northwestern. The Rhode Island Locomotive Works, of Providence, R. I., have built 2 eight-wheel engines for a meter gage road in South America; cylinders, 15 × 20 ins., 48-in. driving wheels. The Baltimore & Ohio has put on its Washington express service some eight-wheel engines, with cylinders 20 × 24 ins., and driving wheels 78 ins. diameter. The company has built at its Mount Clare shops 10 switch engines, and is building 10 ten-wheel engines for fast freight and 12 consolidation freight engines. The Maine Central will receive 4 new engines in April. The Richmond Locomotive & Machine Works, of Richmond, Va., have orders for 15 engines for the Louisville Southern and 10 ten-wheel engines for the Chesapeake & Ohio. The Cleveland, Cincinnati, Chicago & St. Louis is having plans and specifications prepared for 10 eight-wheel passenger and 10 ten-wheel freight engines. Light locomotives are wanted by the Hosch Lumber Co., of Atlanta, Ga., and the Golden Valley Mining Co., of Marion, N. C.

Cars.—The Osgood Bradley Car Co., of Worcester, Mass., is building 30 passenger cars for the New York, New Haven & Hartford. The St. Charles Car Co., of St. Charles, Mo., has delivered 20 passenger cars and 8 flat cars to the Mexican Valley. The Chesapeake & Ohio will place orders for 500 freight cars. The Mt. Vernon Car Co. is building for the Louisville, Evansville & St. Louis some furniture cars 42 ft. long, 9 ft. wide and 10 ft. high. The Atlanta Car Co., of Atlanta, Ga., is ready to begin operations, and has material on hand.

Electric Cars.—The Thomson-Houston Electric Co. has orders for 70 street cars for St. Louis, Mo., 40 for Cincinnati, O.; 28 for Little Rock, Ark.; 20 for Troy, N. Y., and 80 in small lots for several cities.

Railway Buildings.—A. McMullen & Co. are building new shops for the Northern Pacific at Tacoma, Wash. Since June, 1890, the following have been erected: Car repair and erecting shop, 100 × 243 ft.; woodworking shop, 90 × 152 ft.; engine house, etc., 42 × 80 ft.; boiler house, 50 × 76 ft.; coal house, 19 × 76 ft.; smokestack, 150 ft. high; paint shop, 90 × 242 ft.; paint store house, 2 stories, 35 × 90 ft., 2 lavatories, 21 × 42 ft.; machine shop, 120 × 244 ft.; boiler, tank and copper and tin shop, 80 × 321 ft.; coal and iron storehouse, 28 × 150 ft.; office and storehouse, 43 × 254 ft.; dry lumber shed, 40 × 225 ft. All are of brick except the last, which is of frame, with corrugated iron roof. Round house of 22 stalls, coaling station (24 pockets), sand house, oil house, etc. Foundations have been built for the following buildings, which will be erected as soon as the weather permits: Freight car repair shop, 90 × 302 ft; machine shop engine house, 40 × 40 ft.; blacksmith shop, 80 × 192 ft.; storehouse for boiler iron, 25 × 50 ft.; oil house, 43 × 60 ft.; dry kiln, about 100 × 100 ft. Also water tanks, transfer tables, etc.

Road Roller.—An Aveling & Porter steam road roller has been purchased by Mr. W. Rockefeller, for use in the construction of roads on his estate at Tarrytown, N. Y.

Car Wheels.—The Washburn Steel Car Co., of Hartford, Conn., has an order for 704 wheels for the Chicago & Northwestern.

Spikes.—The Robert W. Hunt & Co. Inspection Bureau, of Chicago, Ill., is making tests of railway spikes for the C. H. Dunham Railway Equipment Co., of New York and Chicago.

Companies.—United Railway Supply Co., 97 Water St., New York, N. Y. People's Navigation & Improvement Co., of Jamestown, N. Y.; incorporators, E. A. Burroughs P. H. Hoyt and J. H. Clark; capital stock, $60,000. Adams Direct Process Steel Co., of Buchanan, Va.; President, J. D. Weeks; capital stock, $100,000. Harms-Schlake Brick Co., of Chicago, Ill.; incorporators, C. Harms, W. E. Schlake and C. J. Ford; capital stock, $50,000. Chicago Elastic Metallic Packing Co., of Chicago, Ill.; incorporators, D. W. Mason, T. M. George and J. M. Price; capital stock, $100,000. Eureka Nut Lock Co., of Pittsburg, Pa; incorporators, Wm. H. Hays, John H. Dalzell and D. E. Park. Parsons Ventilator Co., of Jersey City, N. J.; to manufacture apparatus for ventilating cars, steamers, houses, etc.; incorporators, H. F. Parsons, Chase M. Simpson and W. M. Thacher, of New York; capital stock, $200,000.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31; old rails, $21 to $21.50 for iron and $17.25 for steel. Pittsburg: $26.50 to $27; old rails, $25 for iron and $17.75 to $18 for steel. Chicago: $31; old rails, $23 to $23.25 for iron and $15 to $17 for steel.

Foundry Pig Iron.—New York: $14 to $15.50. Pittsburg: $15 to $17. Chicago: $14.50 to $16.

Track Materials.—New York: steel angle bars, 1.7 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.65 to 2.75 cts. with square, and 3.1 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.9 to 1.95 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.85 to 3 cts. with hexagon nuts.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.32 to 4.35 cts. Chicago, 4.15 cts. St. Louis, 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 to 2.1 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 to 2.35 cts.; refined bars, 1.9 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.65 to 2.75 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.